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An articulation of science curricula in grades seven through twelve

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AN ARTICULATION OF SCIENCE CURRICULA IN GRADES SEVEN THROUGH TWELVE

By
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ABSTRACT

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AN ARTICULATION OF SCIENCE CURRICULA IN GRADES SEVEN THROUGH TWELVE
2003-2004
Dr. Dennis Hurley
Master of Arts in Supervision and Curriculum Development

The purpose of this articulation was to align the science curriculum of the Lower Cape May Regional School District with the New Jersey State Core Content Standards and to articulate the 7th and 8th grades curricula with that of the high school. Faculty participated in a summer workshop to develop a curriculum map and to set benchmarks to identify student achievement. A survey was developed and distributed to members of the science and mathematics departments to isolate problems with the curricula and to determine the extent of professional development needed in each department. A second survey was furnished to the students of the district in order to identify their perspective of the current situation. The investigation identified a need to create a unifying philosophy of education for the two buildings in the district, and to create a freshman year of science that better bridges the gap between the two curricula.

MINI-ABSTRACT

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The purpose of this study was to determine the best order in which to teach the sciences in a grade seven through twelve district while maintaining alignment with the New Jersey State Core Content Standards. As a result of this investigation, the district recognized that it needed to create a unifying philosophy of education for the two buildings, and to create a freshman year of science that better bridges the gap between the two curricula.

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I would like to acknowledge and thank those members of my family and friends who have had to endure my moments of panic and those days when I felt so very overwhelmed. Your gifts of patience, letting me blow off steam, and not letting your feeling get hurt were instrumental in my completing this journey.

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Chapter 1

Introduction

Focus of the Study

"The times they are a-changin," popular Bob Dylan lyrics apply more than ever in American education today. Only a few decades ago, the typical liberal arts or college-prep education was for a select few while the majority of the school population prepared for entrance into the factory workforce. Today, school districts across the country are being pressured to prepare the majority of their students for the rigors of college. This pressure seems to stem from either the reduction in the number of factories in the United States or a greater number of parents believing their children deserve a college education. Many educators believe that this sense of entitlement to a particular level of education for all students has resulted in the downfall of American education. They believe the "old school" way of educating students resulted in more intelligent pupils. Conversely, others believe that revisiting the past is not the answer to improve the current situation. Regardless of one's position, American education must improve, especially in the areas of mathematics and science.

A recent article in the New York Times reported that fewer than one half of American students who took the 2003 ACT exams, were prepared to complete a college-level Algebra course. More surprisingly, roughly one-fourth of the students were considered prepared for college biology (Lewin, 2003). For the first time, ACT designed benchmarks indicating a student's readiness for college course work. The scores were designed to indicate a student's ability to achieve a C or better in a college-level course. According to ACT's benchmarks, two-thirds of high school seniors were prepared for college English classes; however, only 40% were equipped to meet the challenges of college Algebra; and only 26% for biology (Lewin, 2003).

Patsy Wang-Iverson, Research for Better Schools, has used the data collected from the Third International Mathematics and Science Survey (TIMSS) report to identify "effective educational practices and professional development in other countries" (Wang-Iverson, 2003). She believes that one of the most important changes to American education must include addressing the need for changes in professional development, beginning with what, how and by whom a content area is taught. She indicates that much can be learned from counterparts abroad. She recommends looking to Japan where the performance of even the best of teachers is enhanced through "lesson study, a long-term, site-based, teacher-led, collaborative, professional development process focused on student thinking" (Wang-Iverson, 2003).

Leon Lederman, director emeritus of the Fermi National Accelerator Laboratory in Batavia, Illinois is a Nobel Prize-winning physicist and the founder and chairman of the Teachers Academy for Mathematics and Science in Chicago. He has spent several years researching what content is taught in American science classrooms as well as in what order the content should be presented. He has suggested that the order in which science is taught needs to be re-evaluated. Traditionally, biology is taught in the 9th grade year followed by chemistry in 10th grade and physics in 11th. The theory is that success in science is driven by mathematics education. Lederman suggests this is a false premise. He recommends teaching physics in 9th grade basing the curriculum on the Algebra skills of the 9th grader. Chemistry would then be offered in 10th grade and biology in 11th grade. He adds that this design enhances a student's desire to take a fourth year of science such as an elective like Anatomy and Physiology or Advanced Placement versions of one of the core courses.

This revolutionary change in high school curricula, addresses the current problems facing classes across the country, as does Wang-Iverson's research which calls for continuous professional development and innovations in effective teaching practices. In 1999, Lederman reported that "reform comes with a need for continuous professional development; weekly meetings of the science and math teachers to improve coherence, design laboratory work, and find the connective inquiries that entangle and unify the disciplines." He further stressed that his is a design for all students regardless of the level of ability or concentration of study; and that all students will benefit in the future from such an education.

Teachers throughout the Lower Cape May Regional School District have dedicated themselves to using best methods to educate their students. They attend workshops, take courses, read periodicals and rely on years of experience to enhance their teaching skills. They do not, however, collaborate. Educators teach independently of one another, generally following Board approved curricula but placing a greater emphasis on individual strengths and preferences.

This study focuses on developing a collaborative process in which individual efforts would be developed into a cohesive course of study benefiting all students in the district. By researching the work of Dr. Lederman and aligning district curricula with state core content standards, the science department established a set of science benchmarks for the district, and re-aligned the course of study. These benchmarks will be used to insure that the students of the district receive an education designed to provide the excitement that true scientific discovery and processing generates.

Purpose of the Study

As stated earlier, times have changed. The majority of students today are engaged in a quest for higher education. Lower Cape May Regional School District is determined to prepare students to meet or exceed demanding college entrance requirements. This articulation project focused on the most current models and theories dealing with the best order in which to teach mathematics and science in grades K-12 with an emphasis on grades 7-12. At a summer workshop for science teachers in grades 7-12, the participants (1) identified the content and sequence in which the curriculum should be taught in alignment with state core content standards; (2) developed a set of benchmarks to track the progress of its students as well as to identify any weaknesses in the curriculum design; (3) used a community-based action research design to produce a curriculum map to be implemented and revised as needed, upon Board approval. Lastly, this project opened up talks of collaboration by supporting the efforts of each individual and discussing the opportunities if collaboration were available. Although still a work in progress, the movement toward collaborative efforts seems possible; and for the first time, teachers seem excited about working together for the greater good of the students.

Definitions

ACT - The ACT Assessment® is designed to assess high school students' general educational development and their ability to complete college-level work. The tests cover four skill areas: English, mathematics, reading, and science. The maximum score achieved on the assessment is 36 with the national average in 2003 being 20.7.

SAT – According to the College Board the SAT is a three-hour test that measures verbal and mathematical reasoning skills students have developed over time and skills they need to be successful academically. The SAT is scored on a scale of 200-800 and is typically taken by high school juniors and seniors.

TIMSS - The Third International Mathematics and Science Study (TIMSS) represents the most extensive investigation of mathematics and science education ever conducted. The study is sponsored by the International Association for the Evaluation of Educational Achievement (IEA) and funded in the U.S. by the National Science Foundation (NSF) and the National Center for Education Statistics (NCES). Approximately 50 countries have participated in this comparative survey of education focusing upon nine-year old students, thirteen-year old students, and students in their last year of secondary education. The study took place in 1995 with a follow up in 1999. The study continued to compare students internationally in fourth and eighth grades in the areas in math and science in the year 2003.

GEPA – Grade Eight Proficiency Assessment – A statewide assessment using benchmarks to measure the proficiencies of students in 8^{th} grade in order to determine the best placement of the student in high school.

HSPA – High School Proficiency Assessment – A statewide assessment using benchmarks to measure the proficiencies of students in the 11^{th} grade. A student who does not demonstrate the ability to meet or exceed the benchmarks set by the state is not permitted to receive a high school diploma.

NCLB – The No Child Left Behind Act was signed into law by President Bush on January 8, 2002. It is designed to restructure teaching so that every student will reach proficiency in all subject matters not just mathematics and reading by 2014. Each state has been charged with developing an assessment which measures student ability as well as develop a statewide accountability system. Each school district must show yearly progress so that all students meet or exceed proficiency by the 2014 deadline. It also requires all states to develop a plan which ensure all teachers are "highly qualified" to teach by the 2005-2006 school year. There are precautions and interventions for those schools that do not progress each year.

Articulation - The method or manner of joining together the curricula in grades 7-12 in order to create a smooth transition of information from one course to the next. An articulation results in content which smoothly and easily identifies the natural connections between the topics as well as the mathematical concepts involved.

Curriculum Map – is a record that addresses the content taught, skills needed by the student to be successful, lesson objectives, resources, assessments, and benchmarks. It also includes an evaluation process which allows for flexibility to change as the needs of the student change.

Benchmarks – Educational benchmarks are a systematic standards-based program by which each student's abilities can be measured. Benchmarks are either grade level or course specific and include broad, general or specific standards.

LCMR – Lower Cape May Regional School District. Located in Cape May, New Jersey, it is a 7-12 school district consisting of two buildings: Richard M. Teitelman School (7-8), and Lower Cape May Regional High School (9-12). It educates approximately 2000 students in the southernmost region of Cape May County.

Best Practices – Best practices are a set of standards that include state-of-the-art technologies and proven educational strategies which enhance student learning.

BOE – Board of Education

Limitations of the Study

This study was limited to the Lower Cape May Regional School District, a 7th-12th grade district in the southernmost region of Cape May County, New Jersey servicing approximately 2000 students. The study was limited to the science department of the district and only to those few teachers who were willing to participate. This district is rich in the tradition of "teacher as an individual" where cooperation with anything new is difficult to attain, especially if the "something new" involves a collaborative approach to education.

Probably the greatest limitation has been the fear or disillusionment teachers have about teaching freshmen, especially teaching physics to freshmen. Physics and mathematics teachers alike often feel that freshmen are not mature enough or academically prepared enough to handle the rigors of physics even if the concepts do not exceed a basic knowledge of algebra. To these teachers, teaching physics using only those concepts in algebra has not been teaching physics, it has been teaching physical science, and their talents were better used elsewhere.

Setting of the Study

Because Lower Cape May Regional School District is located in the southernmost region of Cape May County, New Jersey its rural location does not provide easy access to major industries, institutions of high education or the cultural activities found in most major cities. Tourism and fishing are the primary sources of income for the community. Some families own small, family businesses, but they also tend to be tied to the tourism industry. Since most jobs are seasonal, residents are left without employment opportunities for several months out of each year, and the area experiences an unemployment rate of 13.6% with the state average being 10.7%.

Lower Cape May Regional School District is a regional district with a district rating of B, just above the poorest districts in the state. Its high school provides educational services for approximately 1200 students from the surrounding communities, of which 96% are white and 4% are minorities; 31.5% qualify for free and/or reduced lunch; 22% are classified as special needs (the second highest percentage in the state). The mobility rate is 22.2% and the number of students suspended was 11.6% of the population. According to state reports, 83.8% of Lower Cape May Regional High School's students pass the State's High School Proficiency Test as 11th graders. Each year approximately 38% of the graduating seniors go on to college (Statistics obtained from the MHADA County Needs Assessment Plan, May 2000).

The district services students from three small shore communities and consists of two buildings: a junior high school servicing approximately 800 students in 7^{th} and 8^{th} grades, and a senior high school housing approximately 1200 students in grades 9-12. The two buildings are separated by athletic fields and surrounded by marshes and woods. The district is currently undergoing major construction and renovations to the high school which has had few changes since it was built in 1961. The junior high school had nearly completed its renovations.

The faculty and administration at Lower Cape May Regional High School consists of eight-one faculty members and four administrators: a principal and three assistant principals. The faculty consists of 53% females and 47% males, all of whom are white; while the administration consists of four white males. Within the district, sixty-five percent of the faculty and administration possess a bachelor's degree while 35% have earned a master's degree.

The faculty and administration at Richard M. Teitelman School consist of fifty-seven faculty members and two administrators. The faculty consists of 53% females and 47% males, all of whom are white with one exception. The administration consists of one white male and one white female.

The science department at the high school consists of ten faculty members; six men and four women. Courses offered at the high school include physical science, biology, chemistry and physics for honors, college-prep and general students. Electives include AP Physics and Biology, Organic Chemistry, Anatomy and Physiology, Space

Science, Environmental Science and Marine Biology and Oceanography. Twenty-eight percent of the school's seniors take a fourth year of science.

The science department at the junior high school consists of six members; two men and four women. Each grade level is broken into three teams with one science teacher per team. The curriculum for 7th grade is Life Science; Earth Science is the basis for the 8th grade curriculum. Students at the junior high school perform well on the science portion of the GEPA with 83% scoring highly proficient. None of the students in the junior high school received a letter stating their teacher was unqualified to teach under the new state and federal guidelines. Each member of the science department either has a science degree or has been successfully teaching for at least ten years in the science field.

The nine members of the Board of Education represent the communities of Cape May, West Cape May and Lower Township. These communities generally possess a negative attitude toward education and make school reform difficult. They tend not to be supportive of school initiatives and school budgets, especially those communities with a large senior citizen base.

Organization of the Study

The design and methodology of this study included a three-day workshop in July from the 28th – 30th for teachers in the science departments of both schools. The workshop focused on aligning the current curricula of both schools with the revised core content standards as well as articulating the curricula between the two schools. The workshop consisted of round-table discussions using a "wish list" generated by the intern, research of the literature on best practices for the order of teaching science in grades 7-12, and a review of the current state core content standards. The workshop generated products which clearly demonstrate alignment with the state core content standards, Lower Cape May Regional benchmarks for student proficiencies in science at grades 8 and 12 and a curriculum map for the district. Additionally, it opened discussions for collaboration of teaching strategies and allowed for better understanding of the educational philosophies as well as of the constraints of each building, such as preparing the students for the GEPA tests in 8th grade. This open dialogue has led to a more collaborative approach to teaching with some of the members of the department.

Information was also gathered from a survey sent to each member of the science and mathematics departments at the high school. Departmental meetings of both the science departments and mathematics departments in both schools opened further dialogue on collaborative teaching and the need for professional development in the best teaching practices of the times. No meetings of members from both schools in either the science or mathematics departments were held.

Analysis of the data for this project has been open-ended and on-going and will not be completed by the end of the term. The focus of this project has been to develop an articulation of the courses and content of said courses between the science departments of both schools and the state core content standards in order to serve the needs of the students. This articulation will only be implemented at the earliest during the 2004-2005 school year pending board approval. An action research plan has been used to generate a curriculum map, and to open dialogue and collaboration among the teachers in the science departments within each school as well as between the schools. The curriculum map will be presented to the administrations of both schools and the curriculum committee of the BOE seeking input from these stakeholders. Only then will a final product be submitted for board approval.

Chapter 2

Review of Literature

Introduction

Historically, science education and subsequent reform has lagged behind other subject areas such as English and mathematics. It has been the philosophy of educators for many years that science education is straightforward and only important to those students pursuing a college preparatory education. Because of this philosophy, elementary curricula have placed science education on a share-time basis with social studies, the other lesser important subject matter. With the inception of President Bush's No Child Left Behind Act (NCLB), educators are faced with a dilemma. Currently, few states include science in their assessment of student progress. New Jersey assessments include science in its GEPA, but have yet to implement a science assessment in its HSPA. The No Child Left Behind Act requires all states to test students in science at least once during their elementary, middle and high school years by the 2007-2008 school year. NCLB further requires that science teachers prove they are "highly qualified" by that time as well. Quite obviously the current practices of teaching science for only half the school year and reserving it only for college-prep students would need re-evaluation. Experts say that schools have been forced to begin to pay more attention to studies of U.S. science education that confirm the trends first highlighted by the Third International Mathematics and Science Study (TIMSS) in 1995 and 1999 (Varlas, 2003). These results indicated that students' science performance in the U.S. faltered by the time they reached middle school and then again in high school.

Not only should educators use the TIMSS report to identify trends in American education, but the data collected can be used to learn about effective teaching practices being used around the world. The report also holds a wealth of information on professional development. The old standard of teaching science known as "lecture-lecture-lecture-lab" may be one cause for the decline in national performance. Science teachers should begin to re-evaluate current practices and participate in professional development that supports inquiry-based, hands-on, critical thinking science that engages the student and improves their understanding of science concepts on a deeper level (Varlas, 2003)

In developing curricula that met the new standards set by NCLB and that used those teaching techniques considered best practice, educators discovered that not only did the content taught need to be re-evaluated but so did the order in which science was taught, especially in grades 7-12. The world is a very different place since the last major science education reform. The world today is one of great technological advances that require this generation of students to enter the work force able to think scientifically; that is to use deductive reasoning, logic, and to synthesize concepts generating new applications. Dr. Leon Lederman, physics Nobel Laureate has been and continues to be a vocal supporter of science education reform. He has stated that "a 21st-century person must be armed with a science overview to be able to adapt to these extraordinary times, to be employed by or otherwise profit from the new industries that will emerge, and to participate in the decisions that society must make as to the pace and direction of this technology revolution" (Lederman, 1999).

As the former director of Fermilab, Lederman directed the ARISE (American Renaissance in Science Education) Project, which was a four-year pilot program through Fermilab, the curricula of which was based on state and national standards and was designed to restructure the order in which science should be taught in high schools. The ARISE Project contended that the traditional order of teaching science in high schools – biology in the freshman year, followed by chemistry and then physics resulted in "too many high schools mired in disconnected, fact-loaded, assembly-line-modeled curricula and pedagogy that bears no resemblance to the excitement of true scientific inquiry and discovery" (Wilkinson, 2002). Dr. Lederman and his supporters proposed reversing the sequence of teaching to physics – chemistry – biology. This gave students a chance to "transfer earlier learning into later applications," resulting in improved comprehension from repeated exposure to scientific concepts (Wilkinson, 2002). The Lederman proposal not only addressed the need for curriculum revision but it supported improved professional development. Furthermore, the Lederman design addressed the needs of all students regardless of course of study.

Review of the Problem

Lower Cape May Regional High School was one such school faced with the need for change. In an attempt to raise the standards in the science curricula of the district, LCMR changed the order in which science was taught in the high school. This re-ordering was met with much dissatisfaction by the faculty and has left the district with curricula that has not been articulated between the two schools. Three years ago LCMR created an Honors course of study. One component is an Honors science program following the basic tenets of the ARISE project. The program consists of Honors Physical Science in the freshman year. This is a physics course based on students' algebra skills but also includes several chemistry components. Honors Chemistry is offered in the sophomore year, followed by AP Biology in the junior year, and AP Physics in the senior year. The program is very flexible allowing students the option to move in and out of the program as needed. A major source of contention with this program comes from the mathematics department and the physics teachers who have difficulty with the concept of teaching physics to freshman. It is unclear whether their apprehension arises from their concerns about teaching freshmen in general; or if they question the students' mathematical preparedness. They argue that teaching such a complex subject such as physics with only an algebra background is impossible. However, educators in schools with successful programs indicate that freshmen succeed where upperclassmen do not because their enthusiasm to learn supersedes their mathematic shortcomings. They do agree that teaching physics to students with only an algebra background and not facilitating the math concepts during instruction would be disastrous, however.

The college-bound course of study at LCMR follows a more traditional "track" – physical science followed by biology then chemistry. This program has been comfortable for the math department as well as the physics teachers. The problem with this program is that it is more disjointed and does not demonstrate the connections between the disciplines. Consequently, students have often not elected to take a fourth year of science.

An additional problem that has surfaced over the years is the lack of continuity and articulation within and between the two schools. The junior high school curriculum focuses on life science in 7th grade and earth science in 8th. This does not transition well with the high school. However, the district has been hesitant to change what is taught in the junior high, as students have been reported as doing exceedingly well on the state assessments. Consequently high school teachers are feeling the pressure to teach more demanding courses of study to students without the necessary skills to support such a rigorous program. This pressure has been compounded by students, with parental support, wishing to pursue college programs rich in sciences at the nation's best colleges and universities. The obvious conclusion has been a need for communication between the two schools and their administrations resulting in a true articulation of programs and a review of the courses offered at both schools. This could be accomplished with professional development and further review of best practices and strategies in teaching science and the Physics First Program.

Review of Research Related to the Physics First Program

Why is the Physics First Program important? The answer is simple; this reform, and it is a reform, has concentrated on generating and implementing a coherent, integrated science curriculum that has met or exceeded the state and national standards. By its very design, it has allowed schools to tailor programs that best suit the needs of their students. It has been generally believed that any standards-based science curriculum must contain at least three years of science in conjunction with three years of mathematics. The Physics First Program has fulfilled this requirement and has demonstrated that if presented properly, will generate excitement in learning thereby increasing the number of students taking a fourth year of both math and science, including higher level courses such as Advanced Placement courses. The proposed sequence change introducing physics and its laws of nature and the attributes of the atom first, has generated a natural transition to chemistry. Chemistry then builds on the basic atomic structure and demonstrates molecular formation and interaction. All this basic knowledge supports the concepts taught in today's biology classes. Scientific advances have changed the way biology is taught or rather should be taught. Gone are the days of rote vocabulary memorization and basing all biological theory on taxonomical hierarchy. Today, biology teachers are more accurately teaching biochemistry and the physics-chemistry background proposed by this reform has generated a more logical sequence. Now the science - mathematics articulation has become easily accomplished. Mathematics is currently being taught to high school students as a progression of more complex ideas; by restructuring the order of science education to the same natural progression, the articulation becomes more comprehensive.

There are many unifying themes in this curriculum; however, there are many variations as well. Variations come in the form of what is taught and to what degree. For example, Lederman and his supporters advocate teaching physics in the ninth grade "using only the algebra that is being learned in eighth and ninth grade. Physics, largely mechanics, electricity and magnetism, is concrete, practical, dealing with issues and examples that may be drawn from real life just outside the classroom" (Wilkinson, 2002). Other schools have chosen to use an integrated-method of teaching. These districts have chosen not to catalog the classes as physics or chemistry but teach from a bill of fare covering more than one science genre at a time. Others still have chosen to teach the major concepts of each discipline every year, increasing the complexity as the student progresses through school.

No matter what curriculum choice has been made, those schools that have reported successful programs have one thing in common – thorough and on-going professional development. Diane Houeholder, Coordinator of Science for the Maryland State Department of Education, developed a Physics First Program for the state. Her program began by bringing teachers, administrators, scientist and national experts like Lederman, together to explore not only the need for change but the best sequence in which to teach science in Maryland's schools (Rooney, 2003). They determined Lederman's program best suited their needs and two years ago implemented the program. Continuing to follow Lederman's principles, which supports the need for continuous professional development, Householder opened her Physics First Program by holding workshops for 40 science teachers throughout the state. The initial conversation focused on best practices in instruction. Two follow-up workshops, that included supervisors and teachers, were held and featured experts in the philosophy of restructuring the order of teaching science. A proposed third phase of the program suggests a need for a panel discussion with teachers, supervisors and leaders in the engineering and biotechnology fields (Rooney, 2003).

The success of Maryland's program has been due in part to the acknowledgement of the need for professional development. Patsy Wang-Iverson could not agree more. She has taken a unique look at the TIMSS report and suggests that much can be learned by examining other countries' policies on teacher collaboration and professional development (Wang-Iverson, 2003). Internationally, 77 percent of schools which educate fourth graders have policies and practices that address teacher collaboration and cooperation. In the United States that number is only 40 percent. There is, however, an improvement in the statistics by eighth grade – 79 percent of schools internationally have policy regarding teacher collaboration; whereas, 52 percent of U. S. schools address the need in policy (Martin, 1999). Wang-Iverson suggests that focusing on raising the average performance of teachers through collaboration, rather than celebrating the differences, may result in better meeting the needs of students as they face the higher standards set by NCLB. Modeling "lesson study" as used in Japan affords U.S. teachers a way to demonstrate their highly qualified status as mandated by NCLB. In lesson study, teachers of the same grade or course of study, work together to identify a topic or concept difficult for students to comprehend or even difficult for educators to teach. Together they develop a lesson or series of lessons that they believe will best relay the meaning of the concept to the students. They also develop an assessment used by all to test the success of the lesson. If the lesson is successful it will be taught that way to subsequent classes; if not, it will be redesigned (Wang-Iverson, 2003).

Lederman goes so far as to suggest weekly meetings of mathematics and science teachers to discuss where connections can be made between the subjects, what laboratories can be taught to best demonstrate concepts, and which unifying themes need further concentration in order to bolster collaboration within and between subject concentrations (Lederman, 1999). This may prove difficult in public schools where time and space are at a premium.

Conclusion

Applying the philosophies of the Physics First Program to the needs of the LCMR school district would be difficult. This has been a school district rich in traditions – traditional teaching methods and the concept of the teacher as an individual. Teaching methods currently used by many members of both the science and mathematics departments have consisted of best teaching practices of the 1960's and 70's. Consequently, the district's student population would benefit greatly with enhanced professional development in current best practices. In order to effect real change the district needs to proceed carefully - starting with the science department. The science department has undergone several employee changes in the past few years and has been more receptive to philosophical change. Additionally, many of the members of the department in both schools have adjusted their teaching to use more inquiry-based models. Therefore, the reformation should begin here.

First, the current curriculum would need to be aligned with the state core content standards by identifying any shortcomings and suggesting the most logical place to bridge those gaps. Second, placing physics in 9^{th} grade must be evaluated and a dialogue initiated so that concerns and successes can be addressed. Only then will a true articulation of the mathematics and science curricula within and between the schools take place. Collaboration might also result. Professional development must accompany all phases of the reorganization as it has been demonstrated to be a key to successful programs throughout the world. Once this has been successfully implemented, collaboration with the mathematics department must begin. The natural starting point between the two subjects undoubtedly lies with the 9th grade physical science and the 8th grade algebra courses.

Chapter 3

Design of the Study

Introduction

Three years ago members of the science department of Lower Cape May Regional High School met to discuss the course offerings of the district. The department felt that it had not been providing its students the best quality education it could offer, and therefore, wanted to remedy the situation. Several members of the department had generated curricula for courses they wished to teach. The result was a disjointed offering; courses varied from honors level to general. There was no articulation within the building and no cohesiveness between the courses from the junior high and the high schools. The department recognized the need to re-order the course offerings taught to meet not only the needs of the variety of students in the district, but to articulate better with the junior high school.

Prior to the change, Lower Cape May Regional offered only college-bound and general levels of science which limited students and teachers, and did not match up with courses offered in other subject areas. For example, English, social studies and mathematics all offered honors levels as well as college-bound and general. The science courses were then categorized into three groups – honors, college-bound and general. Each track had flexibility built in so that students could move from one arena to another without jeopardizing their educational goals. Current research as well as the students' mathematical ability and training were taken into consideration before the change was made.

LCMR Science Department Course Offerings

Year/Level	Honors Level	College-bound Level	General Studies Level
Freshman	Algebra-based Physics	Physical science	Physical science
Sophomore	Chemistry	Biology	Biology
Junior	AP Biology	Chemistry	Elective – Field Biology or Science in the changing world
Senior	AP Physics	Physics	Elective

Electives such as Organic Chemistry, Anatomy and Physiology, Marine Biology and Ecology and Environmental Science are available to students who meet the criteria set forth by the district. Students are able to participate in these electives by using an open period in their schedule. The re-alignment has demonstrated an increase not only in elective courses being taken but in honors and college-bound students taking a fourth year of science.

It has not, however demonstrated any apparent increase in student ability or achievement. In addition, teachers of freshmen have reported students having difficulty across curricular levels. There seems to be a difference in teaching methods and philosophy between the two buildings as well as a concern with mathematical ability. However, no statistical data has been collected by the district to support or refute the concerns of the department.

General Description of the Research Design

The purpose of this study was to determine what content and in what order each grade level/course in the science department in grades 7-12 in the district should be taught.

In order to address the concerns of the department, the district offered a summer workshop in July of 2003. (See Appendix A) Members from both schools participated in the alignment and articulation of the curriculum. The committee identified the content currently taught in each grade level/course and aligned it with the New Jersey Core Content Standards.(See Appendix B) Using a community-based action research design, the committee then generated a curriculum map which better articulated the curricula between the schools. As a result of the articulation a series of problems became evident. First, the freshman year was identified as the year of concern. With the old course options students went from Earth science to biology if they were college bound; and to physical science if they were in the general track. With the new ordering, all students would go from Earth science to physical science, a more natural progression. This generated another concern, which was the mathematical ability of the students. The committee resolved this issue by setting a series of benchmarks, one of which required students to have completed and received a B or better in Algebra I in 8^{th} grade in order to participate in the honors program. A member of the committee then suggested benchmarks should be set for all grade levels/courses. The committee agreed and produced science benchmarks for all levels. (See Appendix C)

This articulation is impressive but its value will only be determined by how effective it is in the classroom. It does not address the issue of teaching methods and philosophies between the buildings, and one of the biggest transitional issues with freshmen is that they come from an atmosphere which is fun and imaginative to an arena which is serious and demanding. Both philosophies have merits and drawbacks, and both sets of teachers fiercely defend their philosophies. The problem then becomes administrative and with the GEPA scores being relatively high (98% proficient), administrators see no need to change what is being done in the junior high school. The problem then falls on the high school teachers. Looking past the obvious morale issues, the focus of the study then had to shift to the needs of the high school teachers. A survey was generated and sent out to all high school math and science teachers. (See Appendix D)

Description of the Sampling and Sampling Techniques

Because of the interdependence of math and science and since benchmarks include mathematical aptitude, an anonymous, ten question, survey was sent to all math and science teachers in the high school on October 16, 2003. (See Appendix E) The questions were opinion questions with responses ranging from strongly agree to no opinion. The main focus of the survey was geared toward the honor and college-bound levels since those levels were more dramatically changed and were where the summer workshop directed most of their concerns. A comment section was included to allow teachers to voice concerns not addressed in the survey. Responses to the survey were minimal; only six teachers replied after the first request. A second request was sent on November 3, 2003, and an additional five surveys were returned. (See Appendix F) A verbal request was made for the members of each department to participate at both department meetings, but no additional surveys were returned. Of the nineteen math and science teachers in the high school, eleven people responded.

A second survey was generated for students. In keeping with the format of the research, this survey consisted of six opinion questions regarding their science education along with a comment section for them to air concerns not addressed in the survey. (See Appendix G) Students enrolled in a 3rd or 4th year course such as AP Biology, chemistry, physics and the electives were asked to participate in the survey. The survey was anonymous yet it did ask students to identify the level of study in which they were enrolled. This was done to understand the reasoning for their answers, and to identify or isolate information according to level. Obtaining data based on the level of study was important since the most sweeping changes in program occurred on the honors level. Responses from students were overwhelming and very valuable – students from every course identified for participation did so.

Description of the Data Collection Approach

Surveys from both the teachers and students were collected and tabulated, identifying the number of responses per category. For example, question #1 of the teacher survey asks: Do you agree with the order in which sciences are taught in the high school? The responses were as follows: strongly agree – 3, agree – 5, disagree – 1, strongly disagree – 0 and no opinion – 2. The responses were then evaluated in order to identify any pattern to the answers. For example, with respect to the question, eight respondents answered in the strongly agree or agree categories, one in the disagree or strongly disagree categories, and two in the no opinion category. One can then infer that the overall opinion of both departments would be that of acceptance or agreement of the order in which science is taught at the high school.

Additionally, responses in the comment section of the survey were read and categorized with respect to value and area of concern. For example, several comments dealt with the lack of knowledge on the part of the mathematics teacher in understanding what the science teachers meant by including math in their benchmarks. Were the benchmarks designed to address specific math skills or to weed out students the department felt did not belong? Such responses were used to identify areas of future professional training and collaboration.

Student surveys were handled in the same manner, especially the comment section of the survey. Here, several comments were discarded as rhetorical or as the ranting of a teenager and of no use to the research project.

Description of the Data Analysis Plan

After the data had been collected, categorized and analyzed for patterns, it was compared to current research on the best order of teaching science in high schools. The data was then presented to departments at their monthly department meetings and conversations ensued. Notes were taken at each meeting and the comments, concerns and suggestions were combined with the data and current research to generate a professional development and curricular change proposal.

Chapter 4

Presentation of Research Findings

Introduction

Throughout the course of this study on alignment and articulation of the curriculum, two main questions kept surfacing: a) what impact, if any, has the re-alignment had on student achievement, and b) what changes need to be made in the district to accommodate the needs of the students and teachers in the best possible way? One of the focal points of the study was to determine the best order in which to teach the sciences to the students. Three years ago the district changed the order in which the sciences were taught to honors students. Since the honors students were the only students to participate in the Physics First Program, their responses were scrutinized very carefully. College bound or general students, whose courses of study followed the traditional order, were unable to determine if the change in program was beneficial to them. However, their input was welcomed on a variety of questions.

Since the school district has kept extraordinarily little data on aspects of student development such as, the number of students taking a 4th year of science or the relative success of students taking an honors level program versus a college bound program, much of the data collected was based on faculty and students' perceptions and observations. For example, when asked if teachers believed there were more students taking a 4th year of science, 45% agreed and 55% had no opinion. These results occurred because all of the math teachers responded no opinion and most of the science teachers agreed. Two science teachers indicated there was no conclusive evidence other than a perceived increase in enrollment to determine whether there was, in fact, an increase.

Perceptions and attitudes were the basis for the majority of responses from faculty and students alike. Although not rooted in data, if there is a perceived need for change then change can happen. Research on the best ways to transform the science and possibly mathematics curricula was needed and has been taken into account in this research project.

What impact has the re-alignment had on students?

The survey generated for the students was divided into two sections: questions which made them look introspectively, and questions which enabled them to look externally at their education. Furthermore, the surveys were categorized and tabulated according to course of study: honors, college bound and general.

The first section of introspective questions asked students to identify their willingness to take a 4^{th} year of science, their preparedness for successive courses, their ability to draw connections between the classes, and their satisfaction with their course choices. The results indicated that 100% of honors students intend to take a 4^{th} year of science, 83% of college bound, and only 26% of general students indicated they would also. The question then became whether the results were due to the type of student responding or to the program or course of study the students were following. Only the honor students followed the Physics First Program. To further this dilemma, 88% of the honors students felt that their course of study helped them to draw better connections between the courses, but 70% of college bound and 50% of general students responded the same way. However, only 70% of honors students, 68% of college bound and 76% of general students were satisfied with their course of study. One caveat to the results, of the 18% of honors students who reported dissatisfaction with their course of study; since the survey, all but one of those students dropped to the college bound track (See Appendix H).

The second half of the survey asked the students to look at the way the courses were taught and how science and mathematics were related in their courses of study. Students were asked to indicate whether mathematics classes should be better aligned with the science classes, whether science examples should be used in mathematics classes, and whether there was too big a difference between what was taught in the junior high and in the high school. The results again fell into a pattern which left no conclusive evidence. When asked whether mathematics should be better aligned with the sciences, 77% of honors students, 51% of college bound and 29% of general students agreed. In this case the greater incorporation of mathematics in the honors courses may have resulted in the honor students feeling the need for better alignment between the disciplines. When asked if mathematics classes should use science examples in mathematics class, 76% of honors, 24% college bound and 26% of general students responded in the affirmative (See Appendix H).

One of the greatest conflicts in the district has been the philosophy of education between the two schools in the district. The junior high school heterogeneously groups students in teams and believes all children can learn together; whereas, the high school identifies the different learning abilities of the students and segregates accordingly. With this in mind, students were asked if they perceived too great a difference between what is taught at the junior high school and what is taught in the high school. The results indicated that 41% of the honors, 28% of the college bound, and 33% of the general students agreed that there is too great a difference (See Appendix H). These numbers did not validate the opinions of the high school. Teachers, however, did indicate there was some cause for concern if nearly half of the honors students feel there was too great an academic adjustment to be made in going from the junior high to high school. When students were questioned as to what they meant, the overwhelming response was that at the junior high there is one course of study for all student levels, but in the honors courses at the high school they were overwhelmed by the course difficulty and workload. They recommended an honors course of study at the junior high school that would mirror the rigors of the high school program.

In typical fashion, faculty input was more difficult to attain. One hundred twenty-two students participated willingly; whereas, after several attempts, eleven of the nineteen teachers participated in the survey. Unfortunately, many participated due to nagging rather than from a sense of duty. This may have resulted in the extraordinarily high number of no opinion responses.

The faculty was asked questions similar to those of the students and was to respond in a similar fashion that is, to indicate the degree to which they agreed with a particular statement. The survey was intended to be anonymous; however, the faculty was interested in discussing their responses so it was concluded that seven science and four mathematics teachers responded. The questions were divided into two categories: student performance and professional development. With respect to student performance, when asked if they recognized an improvement in student achievement since the re-alignment, 18% agreed and 81% had no opinion. In response to this question, every math teacher had no opinion, and several science teachers indicated there had been little time or data collection to determine if achievement had increased or not. When the teachers were asked if they had identified a better understanding of the connections between the sciences since the re-alignment, every mathematics teacher responded no opinion and the same science teachers indicated there was no conclusive evidence to support the statement (See Appendix G). However, when asked if there had been more students taking a 4th year of science, the responses varied. Here, 45% of the teachers indicated they had seen an increase in enrollment and 55% had no opinion. Again every math teacher had no opinion. Even when asked if students with an 8th grade background would be capable of succeeding in an algebra based physics class 54% agreed, 9% disagreed and 36% had no opinion – all 36% respondents were mathematics teachers (See Appendix G).

When asked to determine a need for professional development within and between the departments, the results were astounding. Asked if a better alignment between the departments was needed to facilitate student learning, 73% agreed, 9% disagreed and 18% had no opinion. Determining whether professional development was needed in the science department to better understand the impact of a Physics First Program resulted in 36% agreeing, 27% disagreeing and 27% with no opinion. When asked if the mathematics department needed professional development to better understand the impact of the Physics First Program, 45% agreed, 27% disagreed and 27% had no opinion. Lastly, when asked if collaboration between the two disciplined was needed 64% agreed, 18% disagreed and 18% had no opinion (See Appendix G).

From the results, it appeared that the mathematics teachers felt they had no reason to answer questions that were focused on the science department. This was typical for the school district, where teachers work in isolation, and departments compartmentalize and do not interact with other disciplines. The science department, on the other hand, showed a great interest in collaborating with the mathematics department. A possible explanation may be that science teachers use mathematics in their lessons; whereas, mathematics teachers do not necessarily use science examples in theirs. The truth of the matter is that when questioned, mathematics teachers indicated that not only did they not have no opinion on many of the questions asked; they actually had no desire to change anything they did in their classrooms. They felt as though they did not have enough time to teach what they needed, let alone add science examples about which they knew nothing in their lessons. As for a need for professional development to learn how to incorporate new examples, they unanimously agreed they had no interest in professional development.

The mathematics teachers, however, had some observations. They questioned mathematics benchmarks on certain science courses, and wondered whether the science department was using them to weed our "certain" students or if certain courses really required specific mathematics skills. Additionally, they felt as though the order in which AP courses were being offered in the science department was wrong. They believed that not all students in an honors track would want to take AP Biology, especially if they were a mathematics oriented student; and that by ordering sciences to include AP Biology was not to the benefit of all students. They suggested the addition of an honors biology course in the junior year; thereby, allowing students to choose AP Biology or AP Physics in the senior year. Lastly, mathematics teachers indicated a need for programs for the college bound and general students which would better incorporate mathematics and science concepts more appropriate for those students' real life expectations.

Science teachers, on the other hand, were appreciative of the data and offered several suggestions. First, they indicated that they believed that many of the problems with student achievement was not so much a matter of what was taught and in which order, but rather how subjects were taught. They believed that how a subject was taught had a greater impact on student retention than when or in what order the subjects were taught. Secondly, the department felt that to meet the needs of the department as well as those of the students; they would like to utilize the Physics First Program with the college bound level as well.

What changes needed to take place to better meet the need of the students and teachers?

The science department suggested including the college bound student in the Physics First Program. By doing so, the freshman year of science was identified as the problem year. Currently, only those students with a B or better in Algebra have been enrolled in the Physics First Program. Would those students who had not taken algebra in 8th grade be able to be successful with the realignment? The teachers felt that the honors physics course and the college bound physical science course would differ in the math requirement. The faculty agreed with the students' suggestion that an honors program be offered at the junior high school. This would better articulate the curriculum between the elementary school which had an enrichment program for its students who excelled in math and English, with that of the high school honors programs. The mathematics department also suggested the need for curriculum changes in the college bound and general courses which would better incorporate math and science in a practical application format.

Conclusion

There was a collective agreement among the teachers that there must be a better alignment between the departments at the high school as well as between the schools, but few expressed a willingness to participate in professional development to achieve the connections. The shared response was that the changes that need to be made would never happen because they are too dramatic and expansive. With philosophies between the two schools diametrically opposed and attitudes of the teachers so negative they may be right – change cannot happen if it is not wanted and if there is no vision to see it to its conclusion.

Chapter 5

Conclusions, Implications and Further Study

Introduction

Studies which involve perceptions and opinions rather than concrete data pose a unique problem – dealing with the emotions of the people involved. Teachers being a passionate bunch are often unable to delineate between perception and fact which has made dealing with this study even more difficult. The general perception among the participants was that there is a need for change in the curriculum order as well as alignment between and within the disciplines of math and science. However, empathy or disillusionment prevents the teachers involved from becoming willing participants in any school reform.

What impact if any has the re-alignment had on student achievement?

Conclusions and Implications

Since prior to this study no data had been collected by any department including guidance to determine the impact of re-alignment on student achievement or enrollment, students and faculty alike were forced to rely on their perceptions or opinions when responding to the surveys. Science teachers could, however, go back three years since the re-alignment to determine if enrollment in their respective classes had in fact increased. Collectively, they reported a 5% increase in enrollment, and AP teachers reported a 10-15% increase in enrollment over the three year period since the re-alignment. As these reported increases were greater than the school wide increase in enrollment; the re-alignment possibly impacted the enrollment of students taking science, especially with respect to AP courses.

Responses from students indicated they were satisfied with the course in which they were enrolled regardless of their level. Could this be a result of the students being appropriately challenged in their respective courses? According to Dr. Leon Lederman, founder of the Physics First Program, when students are suitably placed in courses following the prescribed order of courses, students are then appropriately challenged and demonstrate feelings of satisfaction (Lederman, 1999). Another tenet of the Physics First Program is that by re-ordering the course offerings in science, students are inclined to take a 4th year regardless of state or school requirements. Results of the survey indicated that 100% of those students currently in the program intend to take a 4th year of science while only 26% of the general students intend to do so. These results support the conclusion that the order in which the courses are offered impacts student interest and increases the number of courses they are willing to take. The problem arises with the college bound results. College bound course offerings follow the traditional route, yet 83% of those students surveyed suggested they would take a 4th year of science. Therefore, there is no conclusive evidence that the order in which the courses are offered affects a student's desire to take additional courses which are not required.

When students were asked if they felt they were able to draw the connections between the sciences in their course of study, 88% of the honors students, 70% college bound and 50% of general students felt they were able to do so. These results were difficult to analyze. At first glance they appeared to indicate that there is no connection between the order in which the courses were offered, as indicated by the 70% affirmative response by college bound students. It seemed that this was the result of the students' ability or skill level rather than the ordering of the courses. However, 21% of college bound students indicated they could not make the connections; statistically this is too great a number to disregard. Based on these numbers the science department recommended that college bound students also follow the Physics First Program but that the freshman physical science program be tailored to meet the math level of the students. It would also provide students a better lateral move if they found themselves in either a too difficult or a less than challenging course of study. The department decided to retain the traditional route for the general studies level since the electives in the 3rd and 4th year were biological in nature.

Proposed LCMR Science Department Course Offerings (2004)

Year/Level	Honors Level	College-bound Level	General Studies Level
Freshman	Algebra-based Physics	Physical science	Physical science
Sophomore	Chemistry	Chemistry	Biology
Junior	AP Biology	Biology	Elective – Field Biology or Science in the changing world
Senior	AP Physics	Physics	Elective

With this proposed change, all lateral moves from college bound to AP in the junior year, would have to be made in the beginning of the year. Students would be too far behind to be successful if they were to move from CB Biology to AP Biology in the middle of the school year. However, a move from CB Biology to AP Physics could be made if students demonstrated they had been enrolled and successful in the appropriate mathematics courses. A recommendation from the mathematics teacher would also be beneficial for placement.

This presents a new set of hurdles to overcome before reform can take place. The school district, the science department in particular, needs to address the concerns of the mathematics department. Those teachers question the need for mathematics pre-requisites in science classes. They question whether the requirement is a means to weed out students not wanted in the classes. The mathematics department would like the science department to list specific mathematics skills needed by the students to be successful in their respective science courses rather than just saying, for example, chemistry students need to be in Algebra II. If the science department could meet these specific needs of the mathematics department, then the mathematics teachers might be able to see the relationships between the disciplines. Once the connections are drawn, then professional development can be used to educate mathematics teachers as to how to utilize science examples to demonstrate mathematics concepts.

What changes need to take place to meet the needs of the students and teachers?
Conclusions and Implications

Professional development and training was and continues to be clearly needed on many levels in the district. Not only does the faculty of Lower Cape May Regional School District need to be educated on specific content-designed strategies to improve teaching, they need to learn how to function as a collegial unit. The physical and philosophical separation between the two schools has left the district with a group of individuals with a disjointed concept of collaboration. The creation of an honors program at the junior high school would not only address the educational needs of the students but also the professional needs of the teachers. It would marry the academic philosophies of the two schools and better articulate the curricula as well. This could be the first step in creating a collaborating organization of educators. It would create an opportunity for teachers from both schools to collaborate and develop the program. To be successful; however, input from both schools as well as the sending districts must be solicited.

Teachers have predicted resistance from the administration if there is a proposal to make any change at the junior high school. In 2003, 98% of the 8^{th} students scored highly proficient/proficient in the science portion of the GEPA, and administrators do not want to do anything to jeopardize the scores. Research and common sense would indicate that increasing the standards for a group of student would not jeopardize their ability to succeed on the GEPA assessments.

Despite the implementation of an honors program at the junior high school, the freshman year of science was identified as the place where the greatest changes needed to be made. Although the students did not fully support this, the teachers felt that in the best interest of the students, changes needed to be made in this transition year. The teachers felt that the freshman year set the tone for the entire high school experience so they proposed rewriting the curriculum.

Finally, the teachers developed a set of school benchmarks to identify the skills students needed to demonstrate by the completion of the 8^{th} and 12^{th} grades (See Appendix C). These benchmarks work in conjunction with the curriculum and the core content standards to define what is to be taught and how students are to perform, and meet the needs of both the students and the faculty by clearly defining what was expected of the student while mapping a linear progression of disciplines for the educators. With the development of the benchmarks, the science department provided a starting point for the math and science departments to begin to collaborate and align their respective branches of learning.

Implications of Study on Leadership Skills

When dealing with educators' perceptions and opinions leadership skills are tested. Planning and organization are vital if the overseer is to survive the barrage of feelings projected by the participants. Learning not to take the attacks personally and working through all the negativity can be difficult, but not impossible to do. If the participants are permitted to voice their opinions yet coaxed to stay focused, valuable work can be completed. Delegation of tasks is necessary to give the participants a sense of ownership of the project, yet appropriate follow up will provide the coordinator with the information necessary to complete the task at hand.

A strong leader does not force the participants to conform, but allows the group to arrive at a consensus realizing that sometimes things will go the way the leader had anticipated and sometimes not. Either way, the coordinator must accept the results.

When dealing with a group that is disinterested, motivating them to participate will produce more favorable results. Again, giving the participants a sense of ownership and a sense that they can elicit change may motivate some to participate. Focusing on those members of the group who have chosen to participate, utilizing their talents and demonstrating commitment to them and the success of the project, can result in happy productive educators.

Implications of Study on Organizational Change

As a result of this study, members of both the mathematics and science departments have initiated conversations for collaboration. This was the first time members of different departments have agreed to work together to form a cohesive curriculum which showcases the interrelationship of the subjects.

The science department has developed an articulated curriculum between the schools which provides freshmen with a smoother transition from junior high to high school expectations. The freshman physical science class has been designated as the course to be rewritten this summer. Additionally, teachers from both schools have volunteered to develop an honors program for science in the junior high school as a pilot program. The high school science department has also included the college bound students in the Physics First Program and has reordered the courses accordingly.

Further Study

Professional development still needs to be addressed in the district. Many of the collaborative pieces developed as a result of this study can be utilized in other disciplines, but only if the district demands collaboration across the curriculum district wide.

Data needs to be collected by the guidance department to track the success of the students in the Physics First Program to verify the benefits, and to expand its use to the general students.

The implementation of an honors program at the junior high school simply makes sense and needs to happen. Since students are currently identified by their mathematics skills as well as by their enrollment in Spanish class, separating them into different courses of study should not be difficult, but it will require a philosophical change and the dissolution of heterogeneous grouping of students which may prove difficult.

Finally, communication between the departments as well as between the schools is necessary for further school reform to take place. Lower Cape May Regional is a district consisting of two schools which act as separate entities. Until there is communication resulting in a unified philosophy and curriculum, married with consistent strategies for implementation, no real reform can take place.

References

Dylan, Bob (1963, 1968). The times they are a-changin'. On *The Times they are A-Changin'*: [record]. Location: Warner Brothers, Inc. Renewed 1991 Special Rider Music.

Lederman, L. M. (June, 1999). A science way of thinking. *Education Week on the Web*, 18(40) 43-56. Retrieved July 16, 2003 from http://www.edweek.org/ew/1999/40leder.h18.

Lewin, T. (2003, August 20). High school seniors weak in math and science tests. *New York Times*. Retrieved August 21, 2003 from http://www/nytimes.com/2003/08/20/education/20ACT.html.

Martin, M.O., Mullis, I.V.S., Gonzalez, E.J., Smith, T.A. & Kelly, D. L. (1999) School Contexts for learning and instruction, *IEA's Third International Mathematics and Science Study*. Retrieved July 23, 2003 from http://isc.bc.edu/timss1995i/schrpt.html.

MHADA County Needs Assessment Plan, Cape May County, May 2000.

Rooney, A. (2003). Maryland studies the pros of putting physics first. *Research for Better Schools: Currents*, 6(2), 7.

Varlas, L. (2003). Teaching science: fewer topics may lead to deeper learning. *Curriculum Technology Quarterly*, 12(4), A.

Wang-Iverson, P. (May, 2003) Learning form TIMSS: making the familiar strange. *Research for Better Schools: Currents*, 6(2), 3-5.

Wilkinson, S.L. (July, 2002). First things first. *Chemical & Engineering News*, 80(27), 1-6.

Appendix A
Summer Workshop
LCMR July, 2003

July 21, 2003

Dear Workshop Participant,

I hope you are enjoying a relaxing and productive summer. As we prepare for the upcoming weeks of workshops, I would like to share with you the syllabus of the day's events and to request you be familiar with your respective course curricula. If you could bring a copy with you that would be great – if not I'm sure we could get a copy from Dr. Allen's office. ☺ I would also request you begin to think about your "wish list" – that is what you would like to have for your classes (if only in a perfect world!).

I look forward to seeing you on Monday July 28, 2003 at 8:30 am in the conference room of the Administration Building. If you have any questions or concerns please feel free to contact me at home 465-8668.

Sincerely,

Mary C. Clark

Day 1

8:30 – 8:45	Welcome
8:45 – 9:15	Why we are here. • reasons for change • articulation, alignment and school benchmarks • concerns and philosophies
9:15 – 10:15	What are we doing? • review Core Content Standards changes • research for HS course order • TIMSS • Other school models
10:15 – 10:30	Break
10:30 – 11:00	What do you want? • groups to work on Wish Lists (individually and collaboratively)
11:00 - 11:30	Sharing • group as a whole to share wished
11:30 – 12:30	Discussion • reality of where we are and what we want

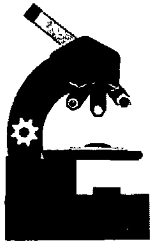
Day 2

8:30 – 8:45	Welcome
8:45 – 9:45	Group Alignment • review current course offerings and align w/ Core Content Standards • work in groups 7th, 8th, biology, chemistry, physics
9:45 – 10:45	Sharing • collaborate as a group of what needs to be done and develop LCMR Benchmarks
10:45 – 11:00	Break
11:00 – 12:30	Update alignment • How does what we have align with what we wish for? • How can we get to where we want to be?

Day 3

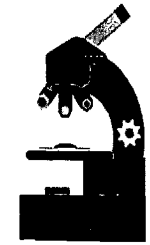
8:30 – 8:45	Welcome
8:45 – 9:45	Round Table • Q & A session • Did we answer all the questions we posed?
9:45 – 10:45	Brainstorming • articulation with the elementary schools – problems specific to a Regional School District • aligning with the Math curricula • use of technology in the curriculum
10:45 – 11:00	Break
11:00 – 12:30	Wrap-up for the future • instituting a science fair at wither or both schools • instituting a science national honor society at the high school • How do we proceed throughout the school year?

Appendix B
Curriculum Alignment with NJ Core Content Standards



7th Grade Life Science Curriculum

NJ Core Content Curriculum Content Standards



Standard	Unit of Discovery
5.1 (Scientific Processes) All students will develop problem-solving, decision-making and inquiry skills, reflected by formulating usable questions and hypotheses, planning experiments, conducting systematic observations, interpreting and analyzing data, drawing conclusions, and communicating results. A. Habits of Mind: evaluate, communicate, replicate, curiosity B. Inquiry/Problem Solving: identify, design, collect data C. Safety: appropriate equipment, practices, and procedures	➢ Lab Safety ➢ Skills of A Scientist ➢ The Scientific Method ➢ Tools Of A Scientist ➢ Scientific Theory vs Law
5.2 (Science and Society) All students will develop an understanding of how people of various cultures have contributed to the advancement of science and technology, and how major discoveries and events have advanced science and technology. A. Cultural Contributions: Contributions by both men and women reflect the social and political climate of their time. Contributions are continuous. B. Historical Perspectives: impact of major historical scientific events and its effect on exponential growth of scientific knowledge.	➢ Careers In Life Science ➢ The Scientific Method ➢ The Metric Unit ➢ Characteristics Of Life ➢ The Human Body ➢ Microscopes ➢ The Cell ➢ Cell Processes ➢ DNA and Genetics ➢ Classification ➢ Ecology

Standard	Unit of Discovery
5.3 (Mathematical Applications) All students will integrate mathematics as a tool for problem-solving in science, and as a means of expressing and/or modeling scientific theories. A. Numerical Operations: express quantities such as decimals, percents and scientific notation. B. Geometry and Measurement: perform labeled quantities and express answers in derived units. C. Patterns and Algebra: express mathematical equations derived from collected data D. Data Analysis and Probability: use tables, graphs, spreadsheets and data base applications to assist in quantitative analysis.	➢ The Scientific Method ➢ Scientific Tools ➢ Laptop Use and Care ➢ The Metric Unit ➢ Characteristics Of Life ➢ The Human Body ➢ Microscopes ➢ The Cell ➢ Cell Processes ➢ DNA and Genetics ➢ Classification ➢ Ecology
5.4 (Nature and Process of Technology) All students will understand the interrelationships between science and technology and develop a conceptual understanding of the nature and process of technology. A. Science and Technology: compare and contrast science with technology B. Nature of Technology: analyze a product or system C. Technological Design: recognize how feedback loops control	➢ Careers In Science ➢ Laptop Use and Care ➢ Microscopes ➢ Genetics/DNA

5.5 (Characteristics of Life) All students will gain an understanding of the structure, characteristics, and basic needs of organisms and will investigate the diversity of life. A. Matter, Energy and Organization: how systems of the human body are related B. Diversity and Biological Evolution: compare and contrast organisms internal and external characteristics, extinction or evolution and survival of the fittest C. Reproduction and Heredity: sorting and recombining of genetic material and their offspring.	➢ Careers In Science ➢ Characteristics of Life ➢ NJ Trees and NJ Birds ➢ Bats ➢ The Human Body ➢ Cells and Cell Processes ➢ Genetics/DNA ➢ Classification ➢ Ecology
5.6 (Chemistry) All students will gain an understanding of the structure and behavior of matter. A. Structure and Properties of Matter: matter is composed of atoms, phases of matter is determined by molecules, and energy, properties of metals and nonmetals, physical properties. B. Chemical Reactions: chemical properties of matter, transfer of energy during chemical reactions, conservation of matter.	➢ Human Body ➢ Cells and Cell Processes
5.7 (Physics) All students will gain an understanding of natural laws as they apply to motion, forces, and energy transformations A. Motion and Forces: forces reinforce or cancel an objects motion, universal law of gravitational pull B. Energy Transformations: sun is major source of energy, various forms of energy, including heat, light, sound, chemical, mechanical	➢ Characteristics of Life ➢ Classification ➢ Cell Processes

5.8 (Earth Science) All students will gain an understanding of the structure, dynamics, and geophysical systems of the earth. A. Earth's Properties and Materials reinforce grade levels B. Atmosphere and Water weather systems and maps C. Processes the Shape the Earth landforms, constructive, destructive processes, successive layers D. How We Study The Earth GIS and GPS	➢ Ecology
5.9 (Astronomy and Space) All students will gain an understanding of the origin, evolution, and structure of the universe. A. Earth, Moon, Sun System moon phases, eclipses, tides, tilt, rotation, and orbital patterns, seasons and weather patterns B. Solar System planet physical characteristics compared to Earth C. Stars sun as a star, and shared characteristics with other stars D. Galaxies and Universe the universe consists of billions of galaxies each containing billions of stars	➢ NJ Trees and Birds
5.10 (Environmental Studies) All students will gain an understanding of the environment as a system of interdependent components affected by human activity and natural phenomena. A. Natural Systems and Interactions impact of catastrophic events on NJ environments B. Human Interactions and Impact compare and contrast practices that affect the use and management of natural resources	➢ The Environment ➢ Ecology ➢ NJ Trees and Birds

8th Grade Earth Science & the NJ Core Content Standards

Standard	Unit of Discovery
5.1 (Scientific Processes) All students will develop problem-solving, decision-making & inquiry skills, reflected by formulating usable questions & hypotheses, planning experiments, conducting systematic observations, interpreting & analyzing data, drawing conclusions, & communicating results. A. Habits of Mind: evaluate, communicate, replicate, curiosity B. Inquiry & Problem Solving: identify, design, collect, data C. Safety: appropriate equipment, practices, & procedures	➢ Lab Safety ➢ Skills of a Scientist ➢ Tools of a Scientist ➢ Scientific Theory-vs-Law ➢ Scientific Method
5.2 (Science & Society) All students will develop an understanding of how people of various cultures have contributed to the advancement of science & technology, and how major discoveries & events have advanced science & technologies A. Cultural Contributions: contributions by both men & women reflect social & political climate of their time. B. Historical Perspectives:	➢ Careers in Earth Science ➢ Metric Unit ➢ Scientific Method ➢ The Earth-Moon System ➢ Chemistry Unit ➢ Oceanography ➢ Newton's Laws of Motion

Standard	Unit of Discovery
5.3 (Mathematical Applications) All students will integrate mathematics as a tool for problem-solving in science, & as a means of expressing and/or modeling scientific theories. A. Numerical Operations: express quantities such as: decimals, percents, scientific notation B. Geometry & Measurement: Perform labeled quantities & express answers in derived units C. Patterns & Algebra Express mathematical equations derived from collected data D. Data Analysis & Probability: graphs, tables, spreadsheets, database application to assist in quantitative analysis of data	➢ Careers in Earth Science ➢ Metric Unit ➢ Scientific Method ➢ The Earth-Moon System ➢ Chemistry Unit ➢ Oceanography ➢ Newton's Laws of Motion ➢ Laptop use & care
5.4 (Nature & Process of Technology) All students will understand the interrelationships between science & technology & develop a conceptual understanding of the nature & process of technology A. Science & Technology: compare & contrast science with technology B. Nature & Technology: analyze a product or system C. Technological Design: recognize how feedback loops control	➢ Careers in Earth Science ➢ Laptops ➢ Space technology ➢ The Earth-Moon System ➢ Chemistry Unit ➢ Oceanography ➢ Newton's Laws of Motion

Standard	Unit of Discovery
5.5 (Characteristics of Life) All students will gain an understanding of the structure, characteristics, & basic needs of organisms & will investigate the diversity of life A. Matter, Energy & Organization in Living Systems: explain how systems of the human body are related B. Diversity & Biological Evolution: Compare & contrast organisms internal/external, evolution & extinction, survival of the fittest C. Reproduction & Heredity: the sorting & recombining of genetic material & their offspring	➢ Careers in Earth Science ➢ Oceanography
5.6 (Chemistry) All students will gain an understanding of the structure & behavior of matter A. Structure & Properties of Matter: All matter is composed of atoms, phases of matter are determined by movement & arrangement of molecules and energy, metal and non-metals, physical properties B. Chemical Reactions: chemical properties of matter, transfer of energy during chemical reaction, conservation of matter,	➢ Careers in Earth Science ➢ Laptops ➢ Oceanography ➢ Newton's Laws of Motion ➢ Chemistry Unit

Standard	Unit of Discovery
5.7 (Physics) All students gain an understanding of natural laws as they apply to motion, forces, & energy transformations. A. Motion & Forces forces can reinforce or cancel an objects motion, universal law of gravitational pull B. Energy Transformations: sun is a major source of Earth's energy, visible, infrared & ultraviolet radiation, various forms of energy heat, light, sound, chemical, mechanical, & electrical, how heat is conducted through matter	➢ Careers in Earth Science ➢ Metric Unit ➢ Scientific Method ➢ The Earth-Moon System ➢ Chemistry Unit ➢ Oceanography ➢ Newton's Laws of Motion ➢ Laptops
5.8 (Earth Science) All students will gain an understanding of the structure, dynamics, & geophysical systems on the Earth. A. Earth's Properties & Materials: Reinforce indicators from previous grade level B. Atmosphere & Water: weather systems & maps C. Processes that Shape the Earth: landforms, constructive, destructive processes, successive layers D. How We Study the Earth: GIS, & GPS	➢ Careers in Earth Science ➢ Metric Unit ➢ Scientific Method ➢ The Earth-Moon System ➢ Chemistry Unit ➢ Oceanography ➢ Newton's Laws of Motion ➢ Weather ➢ Laptops

Standard	Unit of Discovery
5.9 (Astronomy & Space) All students will gain an understanding of the original, evolution, and structure of the universe A. Earth, Moon, And Sun System: moon phases, eclipses, tides,tilt,rotation & orbital patterns, seasons & weather patterns B. Solar System: planet physical characteristics compared to Earth C. Stars: Sun as a star, and shared characteristics of other stars D. Galaxies: the universes consist of billions of galaxies, each containing billions of stars	➢ Careers in Earth Science ➢ Metric Unit ➢ Scientific Method ➢ The Earth-Moon System ➢ Chemistry Unit ➢ Oceanography ➢ Newton's Laws of Motion ➢ Laptops ➢ Earth's Place in the Universe
5.10 (Environmental Studies) All students will develop an understanding of the environment as a system of interdependent components affected by human activity and natural phenomena A. Natural Systems & Interactions: Impact of catastrophic events on New Jersey's environments B. Human Interaction & Impact: compare and contrast practices that affect the use and management of natural resources	➢ Careers in Earth Science ➢ Metric Unit ➢ Scientific Method ➢ The Earth-Moon System ➢ Chemistry Unit ➢ Oceanography ➢ Weather

LCMR Science Dept. Course Alignment with NJ Core Content Standards

Core Standards	Course Title	Units	Objectives
5.1 Scientific Processes	Chemistry	Intro to Chemistry Labs	A-1,2,3,4 B-1,2 C-1
	Physical Science	Intro to Phys Science	A-1,2,3,4, B-1,2 C-1
	Physics	Scientific Observation, Measurement, and Problem Solving	B-1,2 C- 1
	Environmental Science	Aims of Environmental Science and Ecology	A-1,2,3,4, B-1,2 C-1
Core Standards	**Course Title**	**Units**	**Objectives**
5.2 Science and Society	Chemistry	History of Chemistry	B-1,2,3
	Physical Science	Nature of Matter	A-1 B-1,2,3
	Physics	Significant Scientists and their Contributions	B-1,2,3

	Environmental Science	Aims of Environmental Science and Ecology	A-1 B-1,2,3
Core Standards	**Course Title**	**Units**	**Objectives**
5.3 Mathematical Applications	Chemistry	Stoichiometry Atoms, Molecules and Ions Chemical Kinetics Chemical Equations	A-1 B-1 D-1
	Physical Science	Introduction to Science Nature of Matter Changes in Matter Motion and Energy Waves and Wave Prop.	A-1 B-1 C-1 D-1
	Physics	Kinematic Motions Conservation of Energy and Momentum Heat Energy and Thermodynamics Nature of Waves and Sound Electromagnetic Energy	A-1 B-1 C-1 D-1
	Environmental Science	Ecosystems	A-1 C-1 D-1
Core Standards	**Course Title**	**Units**	**Objectives**
5.4 Nature and Process of Technology	Chemistry		
	Physical Science	Intro to Physical Science	A-1 C-1

	Physics		
	Environmental Science	Ecosystems (similarities and differences)	A-1 B-1 C-1
Core Standards	**Course Title**	**Units**	**Objectives**
5.5 Life Science	Chemistry		
	Physical Science		
	Physics		
	Environmental Science	Aims of Environmental Science Ecosystems Ecosystems (similarities and differences) Ecosystems (adaptations)	A-1,2,3 B-1,2 C-1,2,3
Core Standards	**Course Title**	**Units**	**Objectives**
5.6 Physical Science - Chemistry	Chemistry	Properties of Matter Chemical Reactions	A-1 thru 8 B-1,2

	Physical Science	Nature of Matter Structure of Matter Changes in Matter	A-1 thru 8 B-1,2
	Physics		
	Environmental Science	Ecosystems (how they work)	A-1,2,3,4,6,7
Core Standards	**Course Title**	**Units**	**Objectives**
5.7 Physical Science - Physics	Chemistry	Electromagnetic Radiation Heat Transfer/Entropy	B-2,3,4
	Physical Science	Motion and Energy Waves and Wave Prop	A-1,2,3,4,5,6, B-1,3,4
	Physics	Kinematics Motion Thermodynamics Nature of Waves	A-1 thru 8 B-1,2,3,4
	Environmental Science	Ecosystems(how they work)	A-6, B-2,3
Core Standards	**Course Title**	**Units**	**Objectives**

5.8 Earth Science	Chemistry		
	Physical Science		
	Physics		
	Environmental Science	Ecosystems (how they work)	A-1, B-1 C-1,2,3

Core Standards	**Course Title**	**Units**	**Objectives**
5.9 Astronomy and Space Science	Chemistry		
	Physical Science	Motion and Energy	D-2
	Physics		

	Environmental Science		

Core Standards	Course Title	Units	Objectives
5.10 Environmental Studies	Chemistry		
	Physical Science		
	Physics		
	Environmental Science	Aim of Environmental Science Ecosystems(how they work) Ecosystems (similarities and differences) Ecosystems (adaptations)	A-1 B-1,2

LCMR SCIENCE DEPARTMENT
COURSE ALIGNMENT WITH NJ CORE CURRICULUM CONTENT STANDARDS

CORE STANDARD	COURSE TITLE	UNITS	OBJECTIVE
5.1 Scientific Processes	General Biology	Lab Safety, Equipment. Scientific Method, Characteristics of Life, etc.	A- 1, 2, 3, 4 B- 1, 2 C- 1
	CB Biology	Lab Safety, Equipment. Scientific Method, Characteristics of Life, etc.	A – 1, 2, 3, 4 B – 2 C -1
	AP Biology	12 Lab Standards, Case Studies, Reading Digests, Debate and Discussion	A- 1, 2, 3, 4 B- 1, 2 C- 1
	Anatomy & Physiology	Lab Safety, Dissections, Case Studies, Reading Digests, Oral Lab Exams	A- 1, 2, 3, 4 B- 1, 2 C- 1

	Field Biology & Ecology	Ecology – Its Meaning and Scope, Ecosystems	A – 1, 2, 3, 4 B – 1, 2 C - 1
	Marine Biology & Oceanography	Oceanography's Disciplines – Lab, Field and Mariculture Techniques	A – 1, 2, 3, 4 B – 1, 2, C - 1
5.2 Science and Society	General Biology	Communities, Scientists and their Accomplishments etc.	A – 1 B – 1, 2
	CB Biology	Research Paper – Female Scientists, Debates, Mendel, Darwin etc.	A – 1 B – 1, 2
	AP Biology	Debates, Reading digests, Scopes Trial, children of Thalimide	A – 1 B – 1, 2
	Anatomy & Physiology	Reading Digests, Case Studies	A – 1 B – 2, 3

	Field Biology & Ecology	Man and its impact on the environment	A -1 B -1, 2, 3
	Marine Biology & Oceanography	Man's study of the ocean and its impact	A -1 B – 1, 2, 3
5. 3 Mathematical Applications	General Biology	Lab reports – data analysis and probability of results	C – 1 D – 1, 2, 3, 4
	CB Biology	Genetics, Lab Reports – data analysis and probability of results	B – 1 C – 1 D – 1, 2, 3, 4
	AP Biology	Lab Reports, Genetics, Hardy-Weinberg, etc.	A – 1 B – 1 C – 1 D – 1, 2, 3, 4
	Anatomy & Physiology	Case Studies	D - 1

	Field Biology & Ecology		
	Marine Biology & Oceanography		
5.4 Nature and Process of Technology	General Biology	Measurements, experiments, lap-top labs, research etc.	A – 1 B – 1 C – 1
	CB Biology	Measurements, experiments, lap-top labs, research etc.	A – 1 B – 1 C - 1
	AP Biology	12 Labs, lap-top labs, Reading Digests, Research, etc.	A – 1 B – 1 C – 1
	Anatomy & Physiology	Dissections, Case Studies, Reading Digests, Research, etc.	A – 1 B – 1 C – 1

	Field Biology & Ecology	Labs, Human Impact	A – 1 B – 1 C – 1
	Marine Biology & Oceanography	Labs, Human impact	A – 1 B – 1 C – 1
5.5 Characteristics of Life	General Biology	Characteristics of Life, Heredity, changes, Diversity, Simple Organisms, Plants, Animals	A – 1, 2, 3, 4 B – 1, 2 C – 1, 2, 3
	CB Biology	Biological Principles, Cells, Genetics, Invertebrates, Vertebrates	A – 1, 2, 3, 4 B – 1, 2 C – 1, 2, 3
	AP Biology	Biological Principles, Cells, Genetics, Plants, Diversity, Simple Organisms, etc.	A – 1, 2, 3, 4 B – 1, 2 C – 1, 2, 3
	Anatomy & Physiology	Body Systems	A – 1, 2, 3, 4 B – 1, 2 C – 1, 2, 3

	Field Biology & Ecology	Ecology: Meaning and Scope	A – 1, 2, 3, 4
	Marine Biology & Oceanography	The Marine Ecosystem	A – 1, 2, 3, 4
5.6 Physical Science - Chemistry	General Biology		
	CB Biology	Chemistry Unit, Organic – Hydrocarbons, Reactions, Balancing Chemical Equations, etc.	A – 1, 2, 3, 4, 5, 6, 8 B – 1, 2
	AP Biology	Functional Groups, properties of water, basic chemistry review	A – 6, 7, 8 B – 1, 2
	Anatomy & Physiology	Digestion	B -2

	Field Biology & Ecology		
	Marine Biology & Oceanography		
5.7 Physical Science - Physics	General Biology		
	CB Biology		
	AP Biology	Enthalpy and Entropy	B – 2
	Anatomy & Physiology		

	Field Biology & Ecology	Ecology: Its Meaning, Scope & Ecological Systems	B – 1, 2, 3
	Marine Biology & Oceanography		
5.8 Earth Science	General Biology	Evolution	C – 3 D – 1
	CB Biology	Evolution	C – 3 D - 1
	AP Biology	Evolution	C – 3 D – 1
	Anatomy & Physiology		

	Field Biology & Ecology	Comparative Ecology	A – 1 B – 1 C – 1, 2, 3 D - 1
	Marine Biology & Oceanography	Physical Oceanography	A – 1 B – 1 C – 1, 2, 3 D - 1
5.9 Astronomy & Space Science	General Biology		
	CB Biology		
	AP Biology		
	Anatomy & Physiology		

	Field Biology & Ecology		
	Marine Biology & Oceanography		
5.10 Environmental Studies	General Biology	Biotic and Abiotic Factors, ecological succession, biospheres, etc.	A – 1 B – 1, 2
	CB Biology	Human impact on environment	B – 1, 2
	AP Biology	Biotic and Abiotic factors, ecological succession, biospheres, human impact on environment	A – 1 B – 1, 2
	Anatomy & Physiology		

	Field Biology & Ecology	The Ecosystem – Comparative Ecosystem Ecology	A – 1 B – 1, 2
	Marine Biology & Oceanography	Physical Oceanography	A – 1 B – 1, 2

Appendix C
LCMR Science Benchmarks for Grades 7-12

Lower Cape May Regional School District
Science Benchmarks

By the completion of 8th grade, students will demonstrate the following:

1. The student will develop the skills necessary to perform laboratory experiments in a proper environment which includes ensuring the safety of oneself and others.
2. To develop the ability to broaden their knowledge base as well as their reasoning skills. To begin to develop the core skills of a scientist – including accuracy, synthesis, analysis and connection.
3. To develop the ability to follow directions accurately and independently.
4. To understand and accept that the make-up of a scientist isn't uniform and that "scientists" have historically taken many shapes and continue to permeate into a variety of careers.
5. Students should have a basic understanding of the metric system from kilo – deci.

6. To understand the interrelatedness between mathematics and scientific principles.
7. To develop a deeper acceptance of how the study of science relates to them, their environment and what impact they have on it.
8. To develop an understanding of the applications of technology within scientific principles.
9. To accept and appreciate the value of life in their surroundings.

By the completion of 12th grade, students will demonstrate the following:

1. Students will demonstrate and apply the skills necessary to perform laboratory experiments in a proper environment which includes ensuring the safety of oneself and others.
2. To recognize that the laboratory experience is an ongoing process that is used to explore the ever changing phenomena of our world.
3. To differentiate between the concepts of accuracy and precision and to perform statistical analysis of datum. To display the datum in the appropriate formats including multi-technology.

4. The student will demonstrate the ability to work cooperatively and independently on assignments using applicably procedures including independent thought.
5. To begin to investigate and/or pursue career opportunities relating to their daily lives.
6. To demonstrate an understanding of the metric system from giga - pica.
7. To demonstrate and manipulate the interrelatedness between mathematics and scientific principles.
8. To process, and generate a product which demonstrates an understanding of the applications of technology within scientific principles.
9. To demonstrate an appreciation of the uniqueness of the ecosystem with which they live and to express an understanding of the impact individuals have on the system.

Appendix D
Teacher Survey

October 16, 2003

RE: Survey

Dear Colleagues,

As part of my research for my master's thesis, I am requesting your help. I have attached a brief survey for you to complete and return to me by November 14, 2003. I have a deadline of December 1, 2003 for the third chapter of my thesis so I desperately need your cooperation. Please take a few minutes to complete the survey and add any additional comments as needed.

To give you a little background, three years ago the science department re-ordered the course offerings in the high school. We offer honors physical science (which is really physics using only algebra) in the freshman year, followed by honors chemistry, and then AP biology and finally AP physics. We also offer physical science, biology, chemistry, and then physics to college bound students and general students may study physical science, biology, field biology and the like.

My thesis deals with the alignment and articulation of the sciences in the district to determine the best ordering for our students. Since mathematics and science are so closely related I am looking for input from both departments.

Thank you for your understanding and cooperation and I look forward to your input.

Mary C. Clark

Survey questions

1. Do you agree with the order in which sciences are taught in the high school?

   ☐strongly agree ☐agree ☐disagree ☐strongly disagree ☐no opinion

2. The students have demonstrated an improvement in achievement since the reorganization.

   ☐strongly agree ☐agree ☐disagree ☐strongly disagree ☐no opinion

3. The students have demonstrated a better understanding of the connections between the sciences since the reorganization.

   ☐strongly agree ☐agree ☐disagree ☐strongly disagree ☐no opinion

4. More students have been taking a fourth year of science since the reorganization.

   ☐strongly agree ☐agree ☐disagree ☐strongly disagree ☐no opinion

5. More students have been taking higher level courses such as honors and AP since the reorganization.

   ☐strongly agree ☐agree ☐disagree ☐strongly disagree ☐no opinion

6. A better alignment with the mathematics department offerings is needed to facilitate student learning within the reorganization of the sciences.

   ☐strongly agree ☐agree ☐disagree ☐strongly disagree ☐no opinion

7. Students with an algebra background in 8th grade are capable of handling the curriculum of a freshman physics course.

   ☐strongly agree ☐agree ☐disagree ☐strongly disagree ☐no opinion

8. Additional professional development is needed to improve the understanding of the teachers in the science department of the impact regarding a "physics first" program.

   ☐strongly agree ☐agree ☐disagree ☐strongly disagree ☐no opinion

9. Additional professional development is needed to improve the understanding of the teachers in the mathematics department of the impact regarding a "physics first" program.

☐strongly agree ☐agree ☐disagree ☐strongly disagree ☐no opinion

10. Collaboration between the two departments is needed for further understanding regarding the impact of a "physics first" program.

☐strongly agree ☐agree ☐disagree ☐strongly disagree ☐no opinion

Comments:____

Appendix E
Request for surveys to be returned

November 3, 2003

RE: Survey

Dear Colleagues,

A few weeks ago I sent you a survey regarding the articulation of the science and math curricula. In the memo, I requested you send me the survey by November 14th. As I realize the 14th is not upon us, I feel compelled to send a second request. My compulsion is due to the fact that I have only received 6 responses thus far. I realize schedules are hectic and that I am asking a favor of you but I honestly need your input.

I have enclosed another survey, please take a few minutes to fill it out, even if you have no direct knowledge of the situation – your lack of information is as important to me as any opinion or direct knowledge you can share.

If you are one of the six who have responded, Thank You! And, please feel free to "file 13" this request, calling me any names you deem appropriate. ☺

Thank you for your understanding and cooperation,

Appendix F
Student Survey

Student Survey

1. How satisfied with the sequence of your science courses are you?
☐very satisfied ☐satisfied ☐dissatisfied ☐very dissatisfied ☐no opinion

2. Would you have taken a different science course(s) along the way?
☐YES ☐NO If YES, which course(s) and why?________________________

3. Indicate the depth to which you agree or disagree with the following statements:

   a.) This course of study better prepares me for AP courses
   ☐Strongly agree ☐agree ☐disagree ☐strongly disagree ☐no opinion

   b.) I will take a 4th year of science in my senior year.
   ☐Strongly agree ☐agree ☐disagree ☐strongly disagree ☐no opinion

   c.) I believe I am better prepared for each successive year's course than if I had taken the college-bound tract.
   ☐Strongly agree ☐agree ☐disagree ☐strongly disagree ☐no opinion

   d.) I am able to draw connections between concepts from one course to the next.
   ☐Strongly agree ☐agree ☐disagree ☐strongly disagree ☐no opinion

4. Indicate the depth to which you agree or disagree with the following statements:

   a.) The science teachers need to collaborate better so as to not re-teach the same concepts.
   ☐Strongly agree ☐agree ☐disagree ☐strongly disagree ☐no opinion

   b.) Math classes should be better aligned with the science courses.
   ☐Strongly agree ☐agree ☐disagree ☐strongly disagree ☐no opinion

   c.) Math classes should use as examples topics taught in science courses.
   ☐Strongly agree ☐agree ☐disagree ☐strongly disagree ☐no opinion

   d.) There is too big a difference between what is taught at the high school and the junior high.
   ☐Strongly agree ☐agree ☐disagree ☐strongly disagree ☐no opinion

5. Which course of study are you taking?
   Honors College-bound General

6. I would recommend this course of study for all ability levels.
   ☐YES ☐NO If NO, why not____________________________

Comments:____
____
____
____
____
____

Appendix G
Faculty Survey Results

Faculty Survey Results

1. Do you agree with the order in which sciences are taught in the high school?

Strongly agree	Agree	Disagree	Strongly disagree	No opinion
27%	45%	9%	0%	18%

2. The students have demonstrated an improvement in achievement since the reorganization.

Strongly agree	Agree	Disagree	Strongly disagree	No opinion
0%	18%	0%	0%	81%

3. The students have demonstrated a better understanding of the connections between the sciences since the reorganization.

Strongly agree	Agree	Disagree	Strongly disagree	No opinion
0%	18%	0%	0%	81%

4. More students have been taking a fourth year of science since the reorganization.

Strongly agree	Agree	Disagree	Strongly disagree	No opinion
9%	36%	0%	0%	55%

5. More students have been taking higher level courses such as honors and AP since the reorganization.

Strongly agree	Agree	Disagree	Strongly disagree	No opinion
0%	36%	9%	0%	55%

6. A better alignment with the mathematics department offerings is needed to facilitate student learning within the reorganization of the sciences.

Strongly agree	Agree	Disagree	Strongly disagree	No opinion
18%	55%	9%	0%	18%

7. Students with an algebra background in 8^{th} grade are capable of handling the curriculum of a freshman physics course.

Strongly agree	Agree	Disagree	Strongly disagree	No opinion
9%	45%	9%	0%	36%

8. Additional professional development is needed to improve the understanding of the teachers in the science department of the impact of a "physics first" program.

Strongly agree	Agree	Disagree	Strongly disagree	No opinion
18%	18%	27%	0%	27%

9. Additional professional development is needed to improve the understanding of the teachers in the mathematics department of the impact regarding a "physics first" program.

Strongly agree	Agree	Disagree	Strongly disagree	No opinion
9%	36%	27%	0%	27%

10. Collaboration between the two departments is needed for further understanding regarding the impact of a "physics first" program.

Strongly agree	Agree	Disagree	Strongly disagree	No opinion
9%	55%	18%	0%	18%

Appendix H
Student Survey Results

Honor Students Survey Results

1. How satisfied with the sequence of your science courses are you?

Very satisfied	Satisfied	Dissatisfied	Very dissatisfied	No opinion
18%	52%	12%	6%	12%

2. Would you have taken a different science course(s) along the way?

82%	YES	18%	NO	If YES, which course(s) and why?	CB Biology to better prepare for AP Biology

3. Indicate the depth to which you agree or disagree with the following statements:

a.) This course of study better prepares me for AP courses.

Strongly agree	Agree	Disagree	Strongly disagree	No opinion
12%	47%	29%	6%	6%

b.) I will take a 4th year of science in my senior year.

Strongly agree	Agree	Disagree	Strongly disagree	No opinion
82%	18%	0%	0%	0%

c.) I believe I am better prepared for each successive year's course than if I had taken the college-bound tract.

Strongly agree	Agree	Disagree	Strongly disagree	No opinion
35%	47%	6%	0%	12%

d.) I am able to draw connections between concepts from one course to the next.

Strongly agree	Agree	Disagree	Strongly disagree	No opinion
23%	65%	6%	0%	6%

4. Indicate the depth to which you agree or disagree with the following statements:

a.) The science teachers need to collaborate better so as to not re-teach the same concepts.

Strongly agree	Agree	Disagree	Strongly disagree	No opinion
23%	18%	41%	0%	18%

b.) Math classes should be better aligned with the science courses.

Strongly agree	Agree	Disagree	Strongly disagree	No opinion
18%	59%	6%	0%	18%

c.) Math classes should use as examples topics taught in science courses.

Strongly agree	Agree	Disagree	Strongly disagree	No opinion
29%	47%	6%	0%	18%

d.) There is too big a difference between what is taught at the high school and the junior high.

Strongly agree	Agree	Disagree	Strongly disagree	No opinion
6%	35%	47%	6%	6%

Would you recommend this course of study for all ability levels?

0%	YES	100%	NO	If NO, why not?	• too difficult for some • too heavy workload for some • a certain math level is needed to succeed in this track • students come in a variety of packages and not all fit into the same

College Bound Student Survey Results
Selected questions only

1. How satisfied with the sequence of your science courses are you?

Very satisfied	Satisfied	Dissatisfied	Very dissatisfied	No opinion
3%	64%	14%	0%	19%

3 b.) I will take a 4th year of science in my senior year.

Strongly agree	Agree	Disagree	Strongly disagree	No opinion
0%	83%	11%	0%	6%

d.) I am able to draw connections between concepts form one course to the next.

Strongly agree	Agree	Disagree	Strongly disagree	No opinion
8%	62%	20%	1%	9%

4 b.) Math classes should be better aligned with the science courses.

Strongly agree	Agree	Disagree	Strongly disagree	No opinion
0%	51%	32%	0%	17%

c.) Math classes should use as examples topics taught in science courses.

Strongly agree	Agree	Disagree	Strongly disagree	No opinion
0%	24%	32%	0%	34%

d.) There is too big a difference between what is taught at the high school and the junior high.

Strongly agree	Agree	Disagree	Strongly disagree	No opinion
0%	28%	48%	0%	24%

General Students Survey Results
Selected questions only

1. How satisfied with the sequence of your science courses are you?

Very satisfied	Satisfied	Dissatisfied	Very dissatisfied	No opinion
0%	76%	9%	0%	14%

3 b.) I will take a 4th year of science in my senior year.

Strongly agree	Agree	Disagree	Strongly disagree	No opinion
0%	26%	55%	0%	19%

d.) I am able to draw connections between concepts form one course to the next.

Strongly agree	Agree	Disagree	Strongly disagree	No opinion
5%	45%	29%	0%	21%

4 b.) Math classes should be better aligned with the science courses.

Strongly agree	Agree	Disagree	Strongly disagree	No opinion
0%	29%	45%	0%	26%

c.) Math classes should use as examples topics taught in science courses.

Strongly agree	Agree	Disagree	Strongly disagree	No opinion
0%	26%	43%	0%	31%

d.) There is too big a difference between what is taught at the high school and the junior high.

Strongly agree	Agree	Disagree	Strongly disagree	No opinion
0%	33%	52%	0%	15%

Biographical Data

Name	Mary C. Donaldson Clark
High School	Lower Cape May Regional HS Cape May, NJ
Undergraduate	Bachelor of Arts Biology Rosemont College Rosemont, PA
Graduate	Master of Arts Supervision and Curriculum Development Rowan University Glassboro, NJ
Present Occupation	Teacher of Biological Sciences Lower Cape May Regional HS Cape May, NJ