

The Superstructure – The Senior High School Program

CURRENT STATUS:

The superstructure of Miami-Dade's Bridge to Careers is the senior high school program. The courses of study in both mathematics and science are content-laden, and include important and even crucial concepts and principles which students must be able to use to solve problems in the workplace. Graduation requirements for senior high school students in 2000-2001 will include Algebra I, Geometry (for the incoming class of ninth grade), and one additional Level II course. In science, students will take Earth/Space Science, Biology and Chemistry (or Physical Science).

Student performance in mathematics, as measured through the FCAT grade 10, in 1999, showed that 38% of the student standard curriculum population of Miami-Dade County Public Schools scored at the lowest level, level 1. This level indicates little success with the challenging content of the Sunshine State Standards. Twenty-eight percent of the tenth grade students scored at level 2, which indicates limited success.

Employers throughout South Florida, and throughout the country, are sounding a clear and distinct alarm bell that students who are seeking employment cannot apply mathematics or science concepts in the workplace context. Therefore, while Miami-Dade's public high schools must redouble their efforts to teach the concepts and content of Algebra and Biology, Chemistry and Geometry, it must be done with a different focus. That focus must be on a deeper understanding of the concepts coupled with the practical application of those concepts in solving everyday problems.

However, to achieve the level of mathematics, science and technology literacy necessary to successfully meet the workforce development needs, a substantial and significant shift must occur. An emphasis on the practical use of mathematics, science and technology as applied in the workplace, and on the collective educational experiences that enhance student capacity to do so, must be incorporated into the curriculum.

Combining solid theoretical and conceptual development in senior high mathematics and science with practical applications of the concepts in solving problems will be the focus of Miami-Dade Public Schools' program at the senior high level. A system-wide effort of this type will be integrated with the district's school-to-career initiatives, One Community One Goal[®] efforts, and the overall district strategy for transforming the senior high schools through the implementation of the career academy model.

Transforming instructional practices at the senior high school level has been a persistent issue for educational reform throughout the country. Locally M-DCPS is engaged in some important efforts to address this issue in a substantive and pervasive manner. These include the following: establishing academies within high schools for career preparation and curricular focus, Tech-Prep programs/academies, High Schools

That Work initiative, Theme-focused magnet schools K-12 School-To-Career program, and the One Community One Goal[®] initiative.

Transformation should be aided and accelerated by extensive use of research-based programs with documented success such as: Core-Plus Mathematics, Discovering Geometry, Pacesetter, Chem Com, and Active Physics. The extended use of technology-based software such as The Cognitive Tutor Algebra Program, River Deep Algebra, Geometry Sketch Pad, graphing calculators, calculator-based laboratories and probes, and Video-Discovery Science will also help to accelerate the rate of change in teaching practice at the senior high level.

The following goals represent the most important senior high school outcomes of this district comprehensive plan. These goals should be achieved over the next three years, and sustained as regular occurrences in subsequent years.

GOALS:

1. All senior high school sites will develop and implement a mathematics and science instructional improvement team.
2. All feeder patterns will develop and implement feeder pattern support teams in mathematics and science.
3. All senior high school students, including students with special needs, such as LEP and standard curriculum ESE students, will demonstrate performance consistent with the Florida Sunshine State Standards and the senior high school course objectives in mathematics and science.
4. All senior high school students will increase their level of mathematics and science literacy, critical thinking skills, problem-solving ability, and ability to communicate their conceptual knowledge of mathematics and science.
5. All senior high school teachers will attain a comfort level in the curriculum, pedagogy, assessment, and the use of technology.
6. Secondary feeder pattern educational specialists will disseminate information to parents within the community regarding how the local, state, national and international standards in mathematics and science have increased. This will provide information for parents to assist their senior high school students with achieving these standards.

GOALS Continued:

7. All senior high school mathematics and science teachers will increase the use of appropriate technology within the classroom and increase the proficiency of students' use of technology as it assists with problem solving.
8. All senior high school principals and assistant principals will receive professional development designed to support mathematics and science instruction at their school. This support will assist principals and assistant principals in the promotion of mathematics and science careers, and will improve the quality of programs offered at the school site.
9. Instruction and materials that support career awareness in the areas of mathematics and science will be emphasized through schoolwide programs, such as Career and College Days, mathematics and science clubs as well as the honor societies, Career Shadowing experiences, and SECME clubs.
10. The number of senior high school students participating in the SECME program will increase at each school site.
11. The number of senior high school SECME students participating in local university outreach programs will increase at each school site. (e.g., FLAME, Build-It, Girls Symposium)
12. The number of student internships related to the fields of mathematics, science and technology as found in the One Community One Goal[®] initiative with the Miami-Dade Chamber of Commerce and student research programs will increase.
13. The percentage of graduating seniors who are required to enroll in remedial courses at the community college or university levels will decrease substantially.

The following activities will provide the structure for the development and implementation of a rigorous and sustainable senior high school program across the district.

ACTION PLAN:

1. All senior high schools will develop a mathematics and science instructional improvement team consisting of the assistant principal for curriculum, the mathematics and science chairperson and a representative from each course/grade level, in mathematics and science, in order to implement the *Transformative Learning Model* for professional development.

2. Secondary feeder pattern educational specialists will be assigned to feeder patterns and be responsible for facilitating the mathematics and science instructional improvement team at each respective middle and senior high school site.
3. District staff from the Division of USI Mathematics and Science and the secondary feeder pattern educational specialists will assist with the development and monitoring of professional development plans for teachers in mathematics and science.
4. District mathematics and science staff will be assigned to all school-site transition teams for development of academies and implementation of *High Schools That Work* strategies.
5. All grade 9 Algebra I teachers will deliver algebra lessons on the content of each of the five mathematics strands during each nine-week grading period. This includes a spiral of the strands, with an increased intensity of instruction in each consecutive nine-week cycle.
6. All science teachers will incorporate at least 100 minutes of laboratory experience per week into their instruction.
7. Science and mathematics teachers will work together to plan the integration of science and mathematics to support the curriculum of their specific courses.
8. Senior high school mathematics and science teachers will include meaningful mathematics and science projects that emphasize the content strands. These projects will be incorporated into classroom and home learning assignments.
9. All teachers will incorporate effective innovative pedagogy integrating the use of technology and include CRISS strategies for mathematics and science as a part of their effective teaching strategies.
10. Teachers will utilize the district-produced pretest, posttest and additional assessment instruments to assess student learning and attainment of the high school benchmarks.
11. Senior high school mathematics and science teachers will increase the use of current research-based programs and high quality materials with documented success.
12. Each senior high school will provide a Family Math/Family Science and Technology Night, and/or a Career and College Fair to inform the community and the parents about the curriculum, assessment, and courses necessary to pursue various career options.

13. Secondary feeder pattern educational specialists will plan and implement community information meetings for every senior high school within the district, to inform parents and the community about the Third Mathematics and Science Study-Repeat (TIMSS-R) data, relationships, and implications for the FCAT.
14. All high school mathematics and science teachers will encourage students to engage in executive internships with local business partners or universities.
15. Senior high school teachers will recruit SECME students for participation in internships with engineers and other science professionals and increase participation in District-sponsored SECME events.
16. The SECME staff will enhance the project efforts to place student interns in mathematics, science, technology, and engineering work settings.
17. The SECME staff will develop a quality control mechanism in an effort to maintain high standards for the expansion of the SECME program.
18. University outreach program directors will be invited to present their programs at Saturday design seminars and at the District SECME Olympiad.
19. A district committee of supervisors from mathematics and science, applied technology, and other vocational areas (e.g., Agriculture, Health Occupations) will be established to develop curriculum content crosswalks, which integrate mathematics and science concepts with practical applications and career preparation.
20. Mathematics, science and applied technology teachers will co-design professional development with the targeted goal of enhancing the instructional improvement teams.
21. District mathematics staff, science staff, and industry representatives from the targeted industries of One Community One Goal[®] will continue to extend focus group meetings
22. Mathematics and science department chairs and other teacher leaders will facilitate presentations/dialogue with industry/workforce representatives.
23. District staff will collaborate to develop and implement industry internships for math/science teacher leaders.
24. District staff will acquire legislative funding and support for grant proposal Future Educator's Advanced Training (F.E.A.T.) which provides for refocused preparation of mathematics and science teachers by all local colleges and universities, and includes industry mentors for prospective teachers.

25. District staff will extend and enhance university collaborative programs such as the Partnership with Academic Communities (PAC) at Florida International University, to enrich teacher and student experiences with mathematics, and INSTAR to enrich teacher and student experiences with mathematics and science at the University of Miami.

26. A committee of teachers and district staff will expand senior high school robotics projects related to U.S. FIRST competition and associated academic course work leading to product development.

EXPECTED STUDENT OUTCOMES

Senior High School Mathematics-Completing Senior High School

The curriculum will emphasize the use of the language of mathematics as a precise means of mathematical expression, mathematical communication, connections, reasoning, problem solving, mathematical modeling, and the use of technology as a teaching and learning tool. The curriculum will also provide a wide variety of strategies to solve problems. The senior high school curriculum will provide opportunities for students to understand mathematics as inquiry, reasoning, and problem solving; drawing upon connections between mathematics and real-life situations. Mathematical content must emphasize depth of understanding, rather than breadth of coverage.

Instructional design must provide students with a rationale for learning mathematics, address prior knowledge, as well as foster the application of mathematical concepts. Classroom teaching strategies must emphasize active learning, both individually and in groups. Students must be introduced to problem solving, communication, and reasoning through experiments, modeling, investigations, and real-world applications. The instruction should include the use of manipulatives, discovery method, inquiry, higher-order thinking skills, technology, context-based problem-solving activities, cooperative-learning groups, and verbal and written communication.

Assessment must be an integral part of instruction, consistent with the content, goals, and instructional design of the course. Assessment must encourage multiple approaches and make use of diverse forms and methods of assessment. Assessment should probe students' abilities to demonstrate depth, flexibility, and application of learning, as well as provide information on students' progress and learning needs.

This comprehensive senior high school curriculum will prepare students to enroll in post-secondary schools or enable them to join the workforce. They will have the mathematical and technological skills necessary for their vocational choice. They will be skilled in problem solving, communication, and collaborative teamwork.

A. Number Sense, Concepts, and Operations

During grades 9-12, student understanding of systems of numbers should be enhanced through work with matrices. Mathematics instructional programs should foster the development of number and operation sense so that all students are able to reason intelligently with quantitative information.

Students should be able to:

- Understand numbers, ways of representing numbers, relationships among numbers and number systems.
- Understand the meaning of operations and how they relate to one another.
- Use computational tools and strategies fluently and estimate appropriately.

B. Measurement

The notion of measurement includes the real-number line, the rectangular coordinate system and the polar coordinate system. Students understanding of measurement will enable them to both estimate and solve real-world problems.

Students should be able to:

- Understand attributes, units, and systems of measurement.
- Apply a variety of techniques, tools, and formulas for determining measurements.

C. Geometry and Spatial Sense

The classes of objects that form the core of senior high school geometry and spatial sense (lines, angles, polygons, circle, and a variety of three-dimensional objects) are much the same as in previous grades. Geometry learning in grades 9-12 should be focused more on the relationships among these objects than on the objects themselves or on their individual properties. The study of geometry and spatial sense in senior high school provides a means of describing, analyzing, viewing, and understanding the physical world and seeing the beauty in its structure.

Students should be able to:

- Analyze characteristics and properties of two- and three-dimensional geometric objects.
- Select and use different representational systems, including coordinate geometry and graph theory.
- Recognize the usefulness of transformations and symmetry in analyzing mathematical situations.
- Use visualization and spatial reasoning to solve problems both within and outside of mathematics.

D. Algebraic Thinking

Students should leave senior high school with a balanced understanding of functions and algebra. This includes a robust understanding of the forms and properties of a broad array of functions and the ability to use these forms and properties to solve problems in a wide range of contexts.

Students should be able to:

- Understand various types of patterns and functional relationships.
- Use symbolic forms to represent and analyze mathematical situations and structures.
- Use mathematical models and analyze change in both real and abstract contexts.

E. Data Analysis, Statistics and Probability

Students in grades 9-12 build on previous experiences with various ways of displaying univariate data, so that their knowledge can become more formal and can be used to make comparisons. Students should learn what is involved in using surveys, experimental design, and distributions to predict the likelihood of events.

Students should be able to:

- Pose questions and collect, organize, and represent data to answer those questions
- Interpret data using methods of exploratory data analysis.
- Develop and evaluate inferences, predictions, and arguments that are based on data.
- Understand and apply basic notions of chance and probability.

Senior High School Science-Completing Senior High School

The required science courses of Earth/Space Science, Biology, and Chemistry (or Physical Science) will prepare students to develop sophistication in their abilities and understanding of scientific inquiry. Investigations should derive from questions and issues that have meaning for students, such as current events and technology-related problems. Student manipulation, analysis, and interpretation of data strategies need to be modeled by science teachers and practiced by students. Determining the range, mean, and mode values of the data, plotting the data, developing mathematical functions, and looking for anomalous data are all examples of analyses students can perform.

Small group discussions, peer review, posing alternative scientific explanations, discussing sources of experimental error, labeled drawings, writings, and concept mapping should all be used by students to develop their scientific explanations. These, in turn, become the baseline for instruction as teachers help students construct explanations aligned with scientific knowledge, as well as helping them evaluate their own explanations and those made by scientists.

A. The Nature of Matter

Senior high school students develop the ability to relate the macroscopic properties of substances studied in grades K-8 to the microscopic structure of substances. This development in understanding requires students to move among three domains of thought: the macroscopic world of observable phenomena; the microscopic world of molecules, atoms, and subatomic particles; and the symbolic and mathematical world of chemical formulas, equations, and symbols.

Students should be able to:

- Describe how the electron configuration in atoms determines the way that a substance reacts and the energy involved in its reactions.
- Explain how atoms and molecules interact with each other and how their physical properties reflect the nature of their interactions.
- Design and conduct investigations to determine that the rate of reaction among atoms and molecules depend on the concentration, pressure, and temperature of the reactants and the presence or absence of catalysts.
- Explain that nuclear energy is released when small, light atoms are fused into heavier ones.
- Recognize that elements are arranged into groups and families based on similarities in electron structure and that their physical and chemical properties can be predicted.

B. Energy

Energy is an abstract but fundamental concept in science. Learning about energy is essential to understanding changes observed in nature.

Students should be able to:

- Explain that the knowledge of energy is fundamental to all the scientific disciplines.
- Describe that there is conservation of mass and energy when matter is transformed.
- Understand that temperature is a measure of the average kinetic energy of motion of the molecules in an object.
- Discuss that as electric charges oscillate, they create time-varying electric and magnetic fields that propagate away from the source as an electromagnetic wave.
- Debate the societal advantages and disadvantages of each source of energy.
- Know that the first law of thermodynamics relates the transfer of energy to the work done and the heat transferred.
- Explain that the structure of the universe is the result of interactions involving fundamental particles and basic forces and that evidence suggests that the universe contains all of the matter and energy that ever existed.

C. Force and Motion

Force and motion are essential components of the physical and biological world. In grades 9-12, the students will obtain a broader understanding of the role of different forces in the universe and will understand the importance of mathematics in science.

Students should be able to:

- Know that all motion is relative to the frame of reference.
- Calculate acceleration as change in velocity and its relationship to gravitational force.
- Describe electrical and magnetic forces.
- Compare the strength of the forces that hold the nucleus of an atom together to other universal forces and discuss the energy released in nuclear reactions.
- Explain that all forces come in pairs commonly called action and reaction.

D. Processes that Shape the Earth

The physical laws that govern the entire universe are the same ones that govern material interactions. Understanding and applying these laws to geological processes provides insight into how the earth was formed, how it has evolved, and how it continues to change.

Students should be able to:

- Know that 75 percent of the surface of the Earth is covered by water.
- Discuss that temperature, pressure, and the topography of the land influence the water cycle.
- Know that the surface of the Earth is in continuous state of change.
- Discuss climatic changes as a result of many factors.
- Describe the changes that occur within the plates of the Earth.
- Compare changes in Earth climate, geological activities, and life forms.
- Discuss that Earth's systems and organisms are the result of a long, continuous change over time.
- Discuss the interconnectedness of the systems on Earth and quality of life.

E. Earth and Space Science

During the senior high school years, students continue studying the Earth system introduced in grades 5-8. At grades 9-12, students focus on matter, energy, crustal dynamics, cycles, geochemical processes, and the expanded time scales necessary to understand events in the Earth system.

Students should be able to:

- Discuss the relationships between events on Earth and its position in the universe.
- Describe the stages in the development of stars.

- Identify bodies found within and outside the galaxy, astronomical distance and time and stellar equilibrium.
- Discuss various scientific theories on how the universe was formed.
- Describe the various ways in which scientists collect and generate data about the universe.
- Understand that mathematical models and computer simulations are used in the study of the universe.

F. Processes of Life

Students in grades K-8 should have developed a foundational understanding of life sciences. In grades 9-12, students' understanding of biology will expand by incorporating more abstract knowledge, such as the structure and function of DNA, and more comprehensive theories, such as evolution. Students' understandings should encompass scales that are both smaller, for example, molecules, and larger, for example, the biosphere.

Students should be able to:

- Know that body structures are uniquely designed and adapted for their function.
- Understand that biological systems obey the same laws of conservation as the physical systems.
- Know functions of the body such as the communication between the different parts and the response to internal and external stimuli.
- Describe the structure of the cell, the functions of the different parts, how these functions are regulated, and what affects the cell.
- List, describe, and explain, all subunits of DNA and the function of these molecules in the human body.
- Explain evolution and list the factors and consequences involved.
- Describe the interdependence of organisms.
- Understand sexual and asexual reproduction.

G. How Living Things Interact with Their Environment

Living things depend upon one another and the environment. At the senior high school level, students will obtain a more global understanding of these relationships by understanding more intrinsic interactions of the ecosystem.

Students should be able to:

- Know of the great diversity and interdependence of living things.
- Understand the flow of energy through an ecosystem and its effect.
- Describe how chemical elements make up molecules in living things.
- Understand that changes in a component of an ecosystem will affect the entire system.
- Understand genetic variations.
- Discuss ways in which humans are impacting their environment.

H. The Nature of Science

Students should recognize that science, technology, and society are interwoven and interdependent. At the senior high school level, students are exposed to more complex technology necessary to solve and measure more sophisticated scientific problems.

Students should be able to:

- Conduct investigations to explore new phenomena, check previous results, and to test and compare theories.
- Understand the implications and process of new scientific ideas, the importance of scientific responsibility, and the value of technology.
- Discuss that the laws of the universe can be discovered through systemic study.
- Understand the role of scientists in society to understand matters of public concern.
- Understand that those who engage in design and technology to solve problems apply practical scientific knowledge.