The Scaffolding – The Middle School Program

CURRENT STATUS

The goal of mathematics and science curriculum in the middle grades is to provide a solid background for senior high school and beyond – post-secondary education and/or the world of work. M-DCPS' CBC for middle school mathematics provides detailed content maps for each grade level on all five strands in mathematics, delineating this necessary groundwork. The CBC for middle school science provides content and experiences in the eight science strands. Repetitive review of the elementary content in mathematics and science, or modified re-teaching of grade 6 content at grade 7 or 8, will not provide the knowledge, skills, and experiences necessary for senior high school work. Telling middle school students how to perform a particular procedure without giving it a personal context and then requiring them to sit quietly by themselves to practice the procedure goes against their very nature. Support materials for classroom use, such as *Here Come the Sunshine State Standards, Awesome Activities for Achieving Success* and *Focus on Algebra I with a Sunshine State Standard Lens,* encourage student engagement in the learning process. These resources are currently available, but seldom implemented in today's middle school mathematics and science classrooms. The typical practice in middle school classrooms does not provide contextual learning experiences that connect to real-life applications and problem solving. The performance of M-DCPS middle school students on standardized tests such as the Stanford-8 and FCAT has not shown the steady increases realized at the elementary level.

A recent study released by the Council of Chief State School Officers entitled *State Indicators of Science and Mathematics Education 1999* reported that nationally at the eighth grade level, 23 percent of students scored at or above proficient level in the 1996 National Assessment of Educational Progress in Mathematics. Florida had 17 percent of its students scoring at or above proficient level. The scores of minorities were especially low in Florida when compared to white non-hispanic students at the eighth grade level. Florida was tied for second place for states having the greatest disparity between white non-hispanic and minority students scoring at or above the basic level. Such results pointedly illustrate the urgent need for dramatic and different approaches with middle school learners.

M-DCPS' Office of Instructional Technology has been involved in a federal grant entitled, Alliance +. Through this grant teachers from thirty middle schools have received level I and level II training in the use of real-time Internet data for mathematics and science, with the help of the Steven's Institute.

The following goals represent the most important intended middle 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 middle 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 students, including LEP and standard curriculum ESE students, in grades 6-8 will demonstrate performance consistent with the Florida GLE's in mathematics and science.

4. All students will increase their level of mathematics and science literacy, problem-solving ability, and ability to communicate their conceptual knowledge of mathematics and science.

5. All middle school science and mathematics teachers will increase their pedagogical and content knowledge of the five mathematics strands and the eight science strands.

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 middle school students with achieving these standards.

7. All middle 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 middle 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 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 Days, mathematics and science clubs, SECME Program, and Career Shadowing experiences.

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

ACTION PLAN

1. Secondary feeder pattern educational specialists will be assigned and be responsible for facilitating the mathematics and science instructional improvement team at each respective middle school site.

2. Every middle school will develop a mathematics and science instructional improvement team consisting of two representatives from each grade level, one in mathematics and one in science, which also includes department chairpersons and an administrator, in order to implement the Transformative Learning Model for professional development. This process will facilitate teacher collaboration on the integration of mathematics and science content, effective pedagogy, and appropriate assessment practices.

3. National Board-certified mathematics and science teachers and Title I mathematics specialists will provide content-rich support on a regular basis during early release days, teacher work days and Saturdays to continue staff development efforts.

4. District staff from the Division of Mathematics and Science and the secondary feeder pattern educational specialists will assist with the development of professional development plans for teachers in mathematics and science.

5. All middle school science and mathematics teachers will teach the prescribed content and benchmark skills that are in the middle school curriculum.

6. All mathematics teachers will deliver nine lessons on 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.

7. All science teachers will utilize two lessons a week for laboratory activities that build conceptual development of science principles and their application to problem solving.

8. All teachers will incorporate effective teaching strategies for mathematics and science, including CRISS strategies for mathematics and science and the use of the Alliance + technology modules for mathematics and science.

9. Teachers will utilize the district-produced pretest, posttest and additional assessment instruments to assess student learning and attainment of the Florida GLE's.

10. Research-based programs in mathematics and science with a proven record of success in the areas of curriculum connections and student achievement, such as Math In Context (MIC) and the Jason Project, will be incorporated into the middle school program.

11. Each school will provide one Family Math/Family Science Night per semester, to inform the community and parents about the instructional practices, curriculum, and assessments that are currently being used in mathematics and science classrooms.

12 Secondary feeder pattern educational specialists will plan and implement community information meetings for every school within the district, to inform parents and the community about the Third International Mathematics and Science Study Replication (TIMSS-R) data, and implications to improve student achievement on the FCAT.

13 Expansion of the SECME-Rise project, which targets minority female students to build awareness and interest in mathematics, science and engineering careers will take place. There will be an increase in the number of field trips to engineering sites for middle school students to observe mathematics, science, technology and engineering being used in the real world and increase participation in District-sponsored SECME events.

14. The efforts of the INSTAR program, a summer institute held in conjunction with the University of Miami, will be sustained. University collaborative programs such as the Partnership with Academic Communities (PAC) at Florida International University will be extended and enhanced to enrich teacher and student experiences with mathematics.

15. Extending and enhancing the Florida Atlantic University collaborative program, the summer Fractals Institute, designed to enrich teacher and student experiences with mathematics and technology.

16. Mentoring programs with local private sector/business partners for potential career interests will be initiated.

17. The Superintendent's Summer Academy for Mathematics will be implemented, at the conclusion of grades 6, 7, and 8, targeting 100 students, including LEP and standard curriculum ESE students, at each middle school for intensive instruction on algebraic thinking, measurement, and geometry and spatial sense.

EXPECTED STUDENT OUTCOMES

Middle School Mathematics-Exiting Grade 8

Expected Student Outcomes

M-DCPS' CBC supplement in Mathematics grades 6, 7 and 8 provides detailed content maps for each grade level on all five strands in mathematics. The content includes all of the Florida Grade Level Expectations and the benchmarks tested on the grade 8 FCAT.

Teachers must teach the prescribed content using pedagogy appropriate for this age group. Repetitive review of the elementary content in mathematics and science, or modified re-teaching of grade 6 content at grade 7 or 8, will not provide the knowledge, skills, and experiences necessary for senior high school work. Intensive staff development work with teachers is needed to produce a shift in current teaching patterns in the middle school.

A. Number Sense Concepts and Operations

During grades 6-8, student understanding of systems of numbers should be enhanced. 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:

- Demonstrate an understanding of and apply properties and relationships of whole numbers, fractions, decimals, percents, integers, rational and irrational, radicals, numbers with exponents, numbers expressed in scientific notation, absolute values.
- Solve real-world problems using these numbers and their relationships and involving exact answers and/or estimation and approximation, using mental mathematics, calculators, or any other type of technology, as appropriate.

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:

- Estimate and measure quantities in real-world situations, compare and apply relationships of measurements and scales, and derive measurement formulas for surface area and volume of regular three-dimensional shapes.
- Explore and derive formulas for rates, distance, time, and angle measurements, and apply these formulas in problem solving.

- Solve real-world problems involving a variety of measurement situations (length, area, volume or capacity, time, mass/weight), and convert measurement units when necessary.

C. Geometry and Spatial Sense

The classes of objects that form the core of middle school geometry and spatial sense (lines, angles, polygons, circle, and a variety of two-dimensional objects) are much the same as in previous grades. Geometry learning in grades 6-8 should focus on the relationships among these objects. The study of geometry and spatial sense provides a means of describing, analyzing, viewing, and understanding the physical world and seeing the beauty in its structure.

Students should be able to:
- Understand and apply the properties and relationships of geometric shapes.
- Understand, predict and utilize characteristics of patterns in two- and three-dimensional situations.
- Solve real-world problems involving these properties and relationships, including concepts of parallel and perpendicular lines, slopes, transformations, congruency and symmetry, angle and triangle relationships (e.g., The Pythagorean Theorem).

D. Algebraic Thinking

Students should have a balanced understanding of patterns and functions. This includes an 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 the use of variables and the concept of functions, evaluate and simplify expressions, solve equations, and translate verbal expressions into algebraic symbols.
- Understand and apply properties and relationships of first degree equations and inequalities and their graphs in the context of problem solving.
- Use calculators and technology to solve problems, display data, and explain graphs.

E. Data Analysis and Probability

Students in grades 6-8 build on previous experiences with various ways of displaying 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 sampling techniques.

Students should be able to:
- Understand and display data in tables, graphs and charts.

- Interpret and compare data, making predictions and conclusions in a problem-solving context.
- Use calculators and technology when appropriate.
- Determine probabilities and odds of events in a real-world context.

Middle School Science-Exiting Grade 8

The instructional activities of a scientific inquiry should involve students in establishing and refining the methods, materials, and data they will collect. As students conduct investigations and make observations, they should consider questions such as "What data will answer the question?" and "What are the best observations or measurements to make?" Students should be encouraged to repeat data-collection procedures and to share data among groups.

In middle schools, students produce oral or written reports that present the results of their inquiries. Such reports and discussions should be a frequent occurrence in science programs. Students' discussions should center on questions, such as "How should we organize the data to present the clearest answer to our question?" or "How should we organize the evidence to present the strongest explanation?" Out of the discussions about the range of ideas, the background knowledge claims, and the data, the opportunity arises for learners to shape their experiences about the practice of science and the rules of scientific thinking and knowing.

The language and practices evident in the classroom are an important element of doing inquiries. Students need opportunities to present their abilities and understanding and to use the knowledge and language of science to communicate scientific explanations and ideas. Writing, labeling drawings, completing concept maps, developing spreadsheets, and designing computer graphics should be a part of the science education.

A. The Nature of Matter

Substances differ greatly in mass, volume, shape, density, texture, reaction to temperature and light and in many other ways. Most substances exist in different states or phases. Changes from one phase of matter to another involve a gain or loss of energy. If the temperature of a substance is increased, its atoms or molecules tend to move further apart. Elements contain only one kind of atom. Other substances are made up of two or more different elements in which the atoms group together to form molecules. Substances can undergo physical changes that only alter the shape, form, volume, or density of the material but produce no change in chemical composition. Physical changes do not bring about the alterations in the properties of matter that chemical changes do.

Students should be able to:

- Identify various ways in which substances differ (e.g., mass, volume, shape, density, texture, and reaction to temperature and light).
- Describe how the atoms in solids are close together and do not move around easily; in liquids, atoms tend to move farther apart; in gas, atoms are quite far apart and move around freely.
- Investigate the difference between a physical change in a substance (e.g., altering the shape, form, volume, or density) and a chemical change (e.g., producing new substances with different characteristics).
- Describe the general properties of the atom and accept that single atoms are not visible.
- Chemically combine new substances to produce new substances different from the original reactants.
- Relate physical and chemical change to events such as: the water cycles, the carbon cycle, and plant growth.

B. Energy

Energy comes to the earth from the sun, both as visible light and as other forms of electromagnetic radiation, such as infrared and microwave. Most of the energy used today is derived from burning stored energy collected by organisms millions of years ago – non-renewable fossil fuels. Energy exists in many forms and is classified in several ways: mechanical (potential and kinetic), chemical, electrical, magnetic, nuclear, and radiant. The amount of energy in a closed system always remains the same. However, when one form of energy changes to another form, the amount of energy in the original form decreases while the amount of energy in the new form increases. Most of what goes on in the universe involves some form of energy being transformed into another.

Students should be able to:

- Design and perform experiments to show energy exists in many forms and how energy may be used to do work.
- Identify forms of energy and explain how they can be measured and compared.
- Know that energy cannot be created or destroyed, but only changed from one form to another.
- Know the properties of waves (e.g., frequency, wavelength, and amplitude); that each wave consists of a number of crests and troughs; and the effects of different media on waves.
- Understand that most of the energy used today is derived from burning stored energy collected by organisms millions of years ago (i.e., nonrenewable fossil fuels).

C. Force and Motion

Forces have both magnitude (size) and direction. Often, more than one form acts on an object at the same time. The overall effects of these forces are called net force. Among

the common examples of important contact forces are friction, buoyancy, lift, and force exerted by the wind or water. Unbalanced forces produce a change in the motion of the objects on which they act, while balanced forces do not alter the motion on which they act. Simple machines can be used to change the direction or size of a force. Mass remains constant in the universe whereas weight changes from place to place. Some motions keep recurring. These recurring motions lend themselves to measuring time.

Students should be able to:

- Distinguish the characteristics of a body by its position, direction of motion, and speed.
- Diagram models that portray how different type forces (e.g., gravitational, electrical, and magnetic) act at a distance (i.e., without contact) and some act with contact.
- Understand that simple machines can be used to change the direction or size of a force.
- Know that gravity is a universal force that every mass exerts on every other mass.

D. Processes that Shape the Earth

Earth is a unique planet with four major interacting systems: lithosphere (earth), atmosphere (air), hydrosphere (water), and biosphere (life). Conditions that exist in one system influence the conditions that exist in the other system. Sediments of sand and shell of dead organisms may become buried and embedded in their substrates where, in time, they may be subject to great pressure from the weight of materials above. These layers of sedimentary rocks give clues to the age and history of Earth and provide evidence of changing life forms the remains of which are found in successive layers. Understanding the concept of time and size is critical when exploring interacting Earth processes.

Students should be able to:

- Analyze how mechanical and chemical activity shape and reshape the Earth's land surface by eroding rock and soil in some areas and depositing them in other areas, sometimes in seasonal layers.
- Characterize how conditions that exist in one system influence the conditions that exist in other systems.
- Know the ways in which plants and animals reshape the landscape (e.g., bacteria, fungi, worms, rodents, and other organisms add organic matter to the soil; therefore increasing soil fertility, encouraging plant growth, and strengthening resistance to erosion).
- List and describe the consequences of human actions on the Earth's systems.
- Participate in school/community efforts to conserve, and or recycle community resources.

E. Earth and Space

The concept of size of the Solar System is important to understanding the relationship of the planets to one another and to the Sun. Nine known planets orbit the Sun in the Solar System. They vary greatly in size, composition, and characteristics. Many have moons and many have rings of rock and/or ice particles, debris, and gas. Land features and the moons of other planets show evidence of earthquakes, weathering, erosion, and volcanic activity similar to those found on Earth. Light from the Sun reaches Earth in a few minutes, yet some stars are so far away that their light takes several billion years to reach Earth. Stars appear to be made up of the same chemical elements as the Sun. The distance from the Sun allows sufficient light to reach the Earth and sustain life.

Students should be able to:

- Understand the vast size of the Solar System and the relationship of the planets and their satellites.
- Determine, by examining the available data from various satellite probes, the similarities and differences among planets and their moons in the Solar System.
- Know that stars appear to be made of similar chemical elements, although they differ in age, size, temperature, and distance.
- Know that thousands of other galaxies appear to have the same elements, forces, and forms of energy found in the Solar System.

F. Processes of Life

Biological sciences strive to understand the essential processes of life on Earth. Central to an understanding of these processes are the patterns of structure and function in living things. The structures of other living things will be examined in terms of their form and function and integrated to describe the essential processes for their survival on Earth.

Students should be able to:

- Understand that living things are composed of major systems that function in reproduction, growth, maintenance, and regulation.
- Determine through analysis the structural basis of most organisms is the cell and most organisms are single cells, while some, including humans, are multicellular.
- Describe the levels of structural organization for functions in living things include cells, tissues, organs, systems, and organisms.
- Design a model that demonstrates the understanding that cells with similar functions have similar structures, whereas those with different structures have different functions.
- Explain that behavior is a response to the environment and influences growth, development, maintenance, and reproduction.
- Know that the variation in each species is due to the exchange and interaction of genetic information as it is passed from parent to offspring.

- Know that the fossil record provides evidence that changes in the kinds of plants and animals in the environment have been occurring over time.
- Design a model to demonstrate the correlation between healthful living and human body system maintenance.

G. How Living Things Interact with Their Environment

Food webs offer examples of species drawing their mineral and energy needs from other species. Attention is drawn to the transfer of energy from one organism to the next. A central concept is that life is maintained by the continuous input of energy from the sun and by the recycling of the atoms that make up the molecules of living organisms: carbon, oxygen, hydrogen, nitrogen, phosphorous, calcium, potassium, and others. Variation in light, water, temperature, and soil content are largely responsible for the existence of different kind of organisms and population densities in an ecosystem*.*

Students should be able to:
- Design a model that describes how viruses depend on other living things.
- Know that biological adaptations include changes in structures, behaviors, or physiology that enhance reproductive success in a particular environment.
- Understand that the classification of living things is based on a given set of criteria and is a tool for understanding biodiversity and interrelationships.
- Apply the understanding that some resources in your local community are renewable and others are non-renewable.
- Construct a model that displays how biotic and abiotic factors are interrelated and that if one factor is changed or removed, it impacts the availability of other resources within the system.
- Understand that humans are a part of an ecosystem and their activities may deliberately or inadvertently alter the equilibrium in ecosystems.

H. The Nature of Science

Researching and analyzing historical and current discoveries of scientists can provide information about the inquiry process and its effects. Using their intellect and aided by instruments that extend the senses, scientists can discover patterns in nature. Scientific tools such as microscopes, balances, and other instruments facilitate inquiry and problem-solving strategies.

Students should be able to:
- Know that scientific knowledge is subject to modification as new information challenges prevailing theories and as a new theory leads to looking at old observations in a new way.
- Know that accurate record keeping, openness, and replication are essential to maintaining an investigator's credibility with other scientists and society.
- Design an investigation that demonstrates how a change in one or more variables may alter the outcome of an investigation.

- Recognize the scientific contributions that are made by individuals of diverse backgrounds, interests, talents, and motivations.
- Understand that contributions to the advancement of science, mathematics, and technology have been made by different kinds of people, in different cultures, at different times and are an intrinsic part of the development of human culture.
- Know that computers speed up and extend people's ability to locate, collect, sort and analyze data; display via various media, prepare research reports, and share data and ideas with others.