Extreme Math and Science

A Math and Science Enrichment Program at Farnsworth Middle School

Demian Singleton and Carol Kelly
June 10, 2008
Program Goals

- Find and nurture talent by providing and supporting opportunities for students to pursue their interests and curiosities at an appropriate pace and level of complexity.
- Improve students’ competence and confidence in science and mathematics.
- Encourage pursuit of advanced study and/or careers in research or other science/math related areas.
- Broaden math and science experiences to include “real world” applications and studies of/in the field.
- Maximize the number of learners given the opportunity to work with rich and demanding curriculum beyond the classroom with appropriate coaching, support, and mentoring.
- Establish community partnerships as resources for intellectual expertise and professional experiences.
Why Enrichment?

"...first, because intelligence can be affected by environment and opportunity, curriculum for all learners should be rich in opportunity for learners to explore and expand a wide range of intelligences and abilities. Second, curriculum should be designed in ways that both identify and develop high capacity in the widest feasible range of intelligences. Third, curriculum should be flexible enough to address both variability in manifestations of high ability and variability in how talent develops over time in a broad range of learners and talent areas. Fourth, curriculum should plan for development of intelligences in ways that are valid for an intelligence area and domains in which it is expressed."

Dr. Joseph Renzulli
<table>
<thead>
<tr>
<th>The Deductive Model (Prescribed, Presented Instruction)</th>
<th>The Inductive Model (Type III Enrichment)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>The Teacher’s Role...</strong></td>
<td><strong>Teachers and students are partners in formative evaluation based on progress toward goals</strong></td>
</tr>
<tr>
<td>Teachers initiate, determine, control, and micro manage learning</td>
<td>Teachers as coaches, patrons, resource procurers, probes, editors, ombudsmen, and colleagues</td>
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<tr>
<td>Teachers provide feedback in the form of grades based on normative criteria</td>
<td>Teachers view content as objective, impersonal, and value free</td>
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<tr>
<td>Teachers as instructors (disseminators of knowledge)</td>
<td>Teachers personalize, criticize, and emphasize the value-laden character of content (artistic modification)</td>
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</table>

**Plus The Curriculum...**

<table>
<thead>
<tr>
<th>Pre-determined by textbooks or courses of study</th>
<th>Derived as a result of individual or small group student interests</th>
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<tbody>
<tr>
<td>Content driven</td>
<td>Process and product driven</td>
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<tr>
<td>Problems are prescribed, presented, and usually previously solved</td>
<td>Self-selected, open-ended, real world problems</td>
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<tr>
<td>Information is presented for (possible) future use</td>
<td>Information is sought only when needed to help solve a present problem</td>
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<tr>
<td>Knowledge is presented as factual material</td>
<td>Knowledge serves as a vehicle for confrontation with events, issues, ideas, and beliefs</td>
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</table>

**Plus Classroom Organization and Management...**

<table>
<thead>
<tr>
<th>Pre-determined daily time blocks and the weekly allocation of time are</th>
<th>Time is determined by the evolving nature of the determined on the size of units of instruction</th>
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</thead>
<tbody>
<tr>
<td>Whole group activities</td>
<td>Individual and small group activities</td>
</tr>
<tr>
<td>Age/grade grouping</td>
<td>Interest, problem, and common task grouping</td>
</tr>
<tr>
<td>Pre-determined and usually fixed classroom arrangements</td>
<td>Classrooms are arranged to facilitate the accomplishment of the task or the completion of products</td>
</tr>
<tr>
<td>Classrooms are the places where learning takes place</td>
<td>Learning takes place wherever relevant information is gathered or experiences are pursued</td>
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</table>

**Equals The Student’s Role**

<table>
<thead>
<tr>
<th>Students as lesson learners and consumers of knowledge</th>
<th>Students as first-hand inquirers and producers of knowledge</th>
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</thead>
<tbody>
<tr>
<td>Students accumulate and store knowledge for possible future use</td>
<td>Student confronts and constructs knowledge for present use</td>
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<tr>
<td>Students pursue common tasks and activities</td>
<td>Students’ tasks and activities are based on divisions of labor</td>
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<tr>
<td>Students use knowledge to study about problems</td>
<td>Students use knowledge to find and focus problems and to act on problems</td>
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<tr>
<td>Students passively accept knowledge as objective, factual, and correct</td>
<td>Students personalize, interpret, criticize, and dissect knowledge</td>
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</table>
Schools To Watch Criteria

An Initiative of the National Forum to Accelerate Middle Level Reform

- **Academically Excellent.** These schools challenge all students to use their minds well
- **Responsive to Students’ Needs.** These schools are sensitive to the unique developmental challenges of early adolescence
- **Socially Equitable.** These schools are democratic and fair, providing every student with high-quality teachers, resources, and supports
2008 Intel School of Distinction in Science - National Finalist

- Enrichment for all noted as strength in comprehensive science program
- Inductive and inquiry-based learning noted
- Science as a process preferred over delivery of content
- Equal opportunity for all learners to explore and accelerate study of science
Our Beliefs and Commitments

All students, from struggling learners to our most advanced students do better in an atmosphere that values diversity among fellow students’ talent areas and unique strengths, and a broad range of learning options that are designed to promote high levels of achievement, creative productivity, motivation, and respect for the uniqueness of each student.

Enrichment and inductive learning can and should be provided for all students.
School Wide Math and Science Enrichment Model

- Does not replace existing services for gifted and talented students
- Learning experiences are differentiated to meet the needs of participating students
- Individual interests and learning styles drive program
- Supports continuum of learning through acceleration and/or additional enrichment through our gifted and talented programs

One size does not fit all
Organizational Structures

- Implementation coincided with modification to our middle school schedule
- Students participate via push-in, co-taught, and/or pull out experiences
- Individualized and inductive learning conducted throughout the school year
- Workshop and pull-out opportunities are scheduled during access periods and/or tutorials for students from each grade level
- Team and class integrations and/or collaborations are scheduled during core instructional times
Curriculum Development

- **Summer 2007**: Extensive curriculum development completed for formal workshops and special presentations offered throughout the school year.

- **September 2007**: Interest inventories completed by every student to inform planning and development of individualized programs and to identify community partnerships.

- **Ongoing**: Type III learning experiences (Inductive Learning) and integrations with math, science, and/or technology programs.

- **Spring 2008**: Evaluation, revision, and improvement.
Planned Workshops at a glance

Unit Calendar: Kelly, Carol

Guilderland Central School District
Kelly, Carol / Extreme Science 7 / Grade 7 (Farnsworth Middle School)

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<th>Unit</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
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<td>A Comparative Study of Animals</td>
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<td>Properties of Matter REALLY Do Matter!</td>
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<td>An Atmospheric Study using Weather Station Data</td>
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<td>At Home in Each Biome</td>
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<td>Science Skills as a Stairway to STANYS</td>
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<td>Nanotechnology: Cutting it Down to Nano</td>
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<td>Nanotechnology: How small are nanotubes?</td>
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<td>Nanotechnology: Nanosolutions</td>
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<td>Nanotechnology: Nanosugar</td>
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<td>Nanotechnology: Nanoweights</td>
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<td>Nanotechnology: Mitten Challenge</td>
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<td>Energy: The Absorption of Solar Energy</td>
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<td>Energy: How Photocells Work</td>
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<td>Junior Solar Sprint Series: Electrical Power</td>
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<td>Solar Car Series: Angle/Energy Amount</td>
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<td>Solar Car Series: Collecting Sun Power</td>
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<td>Energy: What is pH and why is it important?</td>
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<td>Environmental Models to determine Acid Rain Effect</td>
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<td>The Greenhouse Effect</td>
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<td>NYSERDA: Build a Simple Ammeter</td>
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<td>NYSERDA: Solar-Powered Battery Charger</td>
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<td>Positioning Solar Panels I: Exploring Tracking</td>
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<td>Positioning Solar Panels II: Stationary Panels</td>
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<td>Properties of Solar Radiation: R, T, A</td>
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<td>NYSERDA: Solarize a Toy</td>
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Updated: Thursday, March 27, 2008
Forensic Science

- Fingerprinting with Officer Ginder
- Simulated Blood typing
- Shattered Glass - Geometry and Physics
- Precision and Measurement
- Data Analyses and Conclusions
Taxonomy and Comparative Anatomy

- Advanced study for seventh and eighth grade
- Student specialists trained to deliver instruction and support for other students
- Sixth grade classification program and introduction to comparative anatomy
- Integrated measurement and data collection
Atmospheric Sciences

- Installed digital-feed weather station at Farnsworth
- Collect and analyze real time data
- Prepare and present daily and long-term forecasts
- Visited the National Weather Service at the College for Environmental Sciences and Technology Management
Nanoscience

- Studied the “nanoworld” between atomic and micro/macro scales
- Introduced essential concepts and scales (one billionth)
- Examined real world applications in nanotechnology
- Constructed a Buckyball and Carbon tube models
- Participated in nanocareer events
Additional presentations, events and ideas

- Farnsworth Bureau of Investigation (FBI)
- Hurricane Teleconference
- American Mathematics Competition
- Nanotechnology
- Electrolysis
- Comparative Anatomy
- Metric Olympics
- Planetarium/Astronomy
- Radioactive Decay
- Photovoltaics (solar vehicles)/Solar Energy
- DNA Isolation and Gel Electrophoresis
- Alternative Energy Programs
- Global Positioning Systems and Geocache
- Community Service
Interest Inventories- The Bridge to Inductive learning

- Students identified a wide variety of career and "real life" interests in math and science
- Cluster groups formed around common interests and thematic investigations
- Individual investigations encouraged and supported
- Established a database of professional experts, human resources, and potential partnerships
Inductive Learning - Examples and Highlights

- Inductive (student driven) learning experiences are implemented throughout the course of the year
- Independent Science Project required of all eighth grade students
- Formal presentation in June of each year
- Mentor/mentee partnerships
Integrations and Collaborations

- Ongoing collaborative planning and teaching have maximized connections in learning experiences.
- Math, Science and Technology have been combined to help students find relevance and meaning in each area of study.
- Integration not Isolation.
The Study of Flight

- Students from Mr. McGreevy’s technology class rotated through a program of aerodynamics.
- Students utilized paper models to understand force, thrust, drag, Bernoulli’s Principle and weight on flight.
- Service learning embedded in module
Hoovercraft - An Example of Applied Science

- Application of principles of aerodynamics, forces and motion and flight
- Integrated MST Project
- Aligned with Technology Education Program
Program Evaluation:

- **Demographics**
  - (participation, ability level, ethnicity, gender, grade level)

- **Program Goals**
  - (Mission and Vision for Implementation)

- **Perceptions**
  - (Attitudes, beliefs, observations and impacts)

- **Student Learning**
  - (Standardized tests, authentic assessments, teacher observations)

- **Multiple Measures**
Student Participation

Monthly Participation

<table>
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<tr>
<th></th>
<th>Grade 6</th>
<th>Grade 7</th>
<th>Grade 8</th>
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<tbody>
<tr>
<td>Sept.</td>
<td>109</td>
<td>161</td>
<td>134</td>
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<td>Oct.</td>
<td>114</td>
<td>207</td>
<td>165</td>
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<td>Nov.</td>
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<td>Dec.</td>
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<td>March</td>
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<td>April</td>
<td>124</td>
<td>105</td>
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<td>May</td>
<td>153</td>
<td>142</td>
<td>167</td>
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Demographics

Participation by Gender

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Male</th>
<th>Female</th>
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<tr>
<td></td>
<td>47</td>
<td>53</td>
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Demographics

Demographics (Based on NYS BEDS Data and Categories)

<table>
<thead>
<tr>
<th>Percentage</th>
<th>African American</th>
<th>Asian or Pacific Islander</th>
<th>Hispanic</th>
<th>White (not Hispanic)</th>
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<tbody>
<tr>
<td>Enrichment Program</td>
<td>4.1</td>
<td>8.2</td>
<td>2.2</td>
<td>85.5</td>
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<tr>
<td>Farnsworth Middle School</td>
<td>4.5</td>
<td>7.4</td>
<td>2.4</td>
<td>85.7</td>
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Perceptions - Student Surveys

6. If you are presently in 6th or 7th grade, would you like to continue to participate in a math/science program like this?

5. I have a better understanding of what scientists/mathematicians do.

4. Because of this program I am more excited about math/science.

3. I learned some things in this program that I can use in my math/science classes.

2. I am more aware of the importance of math/science in everyday life.

1. Because of this program, I feel better about being able to learn math/science.
Student Achievement and Learning - A Look Ahead

- **Goal:** Conduct longitudinal comparisons of standardized test results to participation in Extreme Learning Program

- Analyze achievement data to determine relative effect(s) of inductive and inquiry-based learning on student performance

- Disaggregate data to evaluate relative effect on subgroups (special education, gender, etc.)
Program Goals- How are we doing?

- **Year 1**- Based on all measures conducted thus far, the Extreme Math and Science Program is meeting its original program goals.
  - Student participation has exceeded expectations.
  - Survey results indicate favorable student response and interest.
Future Goals and Aspirations

- Continue to identify and forge community connections to enhance enrichment experiences
- Maximize potential and use twenty-first century technologies (e.g. distance learning)
- Further develop mathematics enrichment connections
- Continue collaborative model for development of STEM activities and collective growth of math, science and technology educators
- Increase public awareness of meaning and opportunity for enrichment for all learners
- Initiate creative scheduling options to sustain learning experiences
References


