Science Program Evaluation Summary
Elementary Level (K-5)

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The original meetings for this Program Evaluation began in the fall of 2008 and continued through the end of the 2008-2009 school year. Completion of the program evaluation was delayed by a reduction in curriculum staffing and was resumed in the summer of 2011. In the summer of 2011, all K-5 curricula were reviewed and adjustments were made based on new science kits adopted for use in 2008-09. The standards were also updated to reflect the 2009 NJ Science Core Curriculum Content Standards and the 8.1 Technology Standards. The above listed K-5 Bernards Township faculty members were involved in the gathering and analysis of data.

PHILOSOPHY OF SCIENCE EDUCATION

Education in science introduces students to the community of scientists, to the traditions of science, and to scientific exploration. Through the experiences provided in learning science, students become acquainted with the processes by which scientific concepts are created and then explored. Knowledge of these processes and concepts leads to the awareness that science is not a set of findings but rather the search for them. This awareness is accompanied by the understanding that issues created by the advance of science can only be resolved by moral judgment and political choice.

Science education addresses the students' need to deal with science as part of our culture. For some students, the experiences of science education initiate or respond to a personal interest in preparing to enter those courses of study and training that led to participation in the democratic community of pure and applied scientists. In addition, science education prepares all students to respond to scientific information regarding the social and personal issues raised by technology and to be functional members of the society.

Students need to understand the interrelations between science and technology and develop a conceptual understanding of the nature and process of technology. Students will combine their understanding of the nature of technology and science in order to develop their abilities to make predictions, decisions, think critically, and ultimately to problem solve. Science will continue to advance with the knowledge and application of technology.

Students learn science best when they have opportunities to model the methods of science, to learn by doing. This complements students' development as they move from dependence on concrete activities to tentative experiences with abstract thinking. At all grade levels, educators strive to provide guidance and stimulate students' curiosity and interest in science.

The content of science education is selected to meet students' needs. The content provides for the development of science concepts that are encountered and explored using the processes of science. There are opportunities for independent critical thinking through hands-on activities and a discovery-based program. These encourage a healthy skepticism.

Students learning science collect real data in classrooms, laboratories, and the outdoors. They record observations and measurements done on large and small scales, in qualitative and quantitative modes. They manipulate apparatus and follow directions to assemble and disassemble it. They analyze, manipulate, and communicate data using scientific terminology. They use mathematics to find patterns, discover relationships, and generate explanations and employ quick mental estimates for many mathematical operations.

Through the exploration of matter, motion, forces, space, and earth, students will find that science is connected to their everyday lives. Students need to understand the environment as a system of interdependent components affected by human activity and phenomena. From the study of organisms to how our universe was created, students can see the relationship between their lives and global issues.

The outcomes of science education are recognized when students…

1. demonstrate the knowledge and use of the processes of science
2. demonstrate knowledge of and appreciation for the nature of science
3. apply knowledge in the science disciplines
4. demonstrate skills for applying the processes, the knowledge, and the appreciation of science to issues wherein science, technology, and society meet
5. demonstrate an understanding of the interrelationship between science and technology
6. demonstrate an understanding of the interrelationship between human activity and the environment

The student who has achieved mastery in science education has experienced, can describe, and can choose to use the overall purpose of science: to search for truth in the world in which we live and beyond.

What is Inquiry?

For many years, the concept of scientific inquiry has been used to focus the science education community on the need to incorporate scientific knowledge along with scientific practices. An inquiry approach focuses first on process and then on content knowledge to support it. This runs counter to many instructional models that first focus on the basic core content and then seek to find ways to apply it to practice.

In 2011, Achieve and the National Research Council developed a framework for the next generation science standards. Much like the Common Core in Mathematics and Language Arts, the Next Gen Science Standards will serve as national integrated K-12 standard for Science, Technology, Engineering, and Mathematics (STEM). The Next Generation Science Frameworks focus on 3 dimensions that truly connect the Science, Technology, Engineering, and Mathematics represented by STEM.

"The overarching goal of our framework for K-12 science education is to ensure that by the end of 12th grade, *all* students have some appreciation of the beauty and wonder of science; possess sufficient knowledge of science and engineering to engage in public discussions on related issues; are careful consumers of scientific and technological information related to their everyday lives; are able to continue to learn about science outside school; and have the skills to enter careers of their choice, including (but not limited to) careers in science, engineering, and technology" (Next Gen Science Frameworks, National Academies, 2011). While scientific inquiry is still a key component of the science education lexicon, the term has been supplanted by the more general term, practices.

Curricular Alignment

The desired outcomes for science instruction are based on New Jersey's Core Curriculum Content Standards. For science, there are four standards, revised in 2009, that must be addressed by the curricula. They are:

- **5.1 Science Practices:** All students will understand that science is both a body of knowledge and an evidence-based, model-building enterprise that continually extends, refines, and revises knowledge. The four Science Practices strands encompass the knowledge and reasoning skills that students must acquire to be proficient in science.

- **5.2 Physical Science:** All students will understand that physical science principles, including fundamental ideas about matter, energy, and motion, are powerful conceptual tools for making sense of phenomena in physical, living, and Earth systems science.

- **5.3 Life Science:** All students will understand that life science principles are powerful conceptual tools for making sense of the complexity, diversity, and interconnectedness of life on Earth. Order in natural systems arises in accordance with rules that govern the physical world, and the order of natural systems can be modeled and predicted through the use of mathematics.

- **5.4 Earth Systems Science:** All students will understand that Earth operates as a set of complex, dynamic, and interconnected systems, and is a part of the all-encompassing system of the universe.

The curriculum in Bernards Township has been aligned to the New Jersey Core Curriculum Content Standards through a program of curriculum review and revision and the most recent updates were achieved in the summer of 2011. During the curriculum writing, 15 Cumulative Progress Indicators (CPIs) were identified as not being specifically noted in the K-5 curriculum. These CPIs were reviewed as part of the program evaluation process and cross checked with current curricular goals. All 15 of the CPIs were linked to the current curriculum with minimal alterations to the existing objectives and activities.

5.3.6.A.1 Model the interdependence of the human body's major systems in regulating its internal environment. (Health)

- ★ **<u>Grade 3</u> Human Body: Coordination Lessons "Timing Your Responses" in which students learn that the brain regulates all bodily movement.**
- ★ **<u>Grade 5</u> Covered in 5th grade health curriculum**

5.4.6.A.1 Generate and analyze evidence (through simulations) that the sun's apparent motion across the sky changes over the course of a year.

- ★ **<u>Grade 2</u> In the Sun, Moon, and Stars unit, students monitor and study the sun's apparent motion across the sky is covered (i.e. day compared to night).**

5.4.6.A.4 Compare and contrast the major physical characteristics (including size and scale) of solar system objects using evidence in the form of data tables and photographs.

- ★ **<u>Grade 2</u> Addressed in 2nd grade LA curriculum (specifically in <u>Magic School Bus: Lost in Solar System</u>).**

5.2.6.B.1 Compare the properties of reactants with the properties of the products when two or more substances are combined and react chemically.

- ★ **<u>Grade 2</u> Covered extensively throughout investigations in Changes unit.**
- ★ **<u>Grade 4</u> Earth Materials: Discussed as part of vinegar and calcite experiment that shows the effects of weathering.**

5.4.6.G.3 Describe ways that humans can improve the health of ecosystems around the world.

- ★ **<u>Grade 5</u> Ecosystems unit – lessons on pollution and extension projects at end of unit**

5.2.2.C.1 Compare, citing evidence, the heating of different colored objects placed in full sunlight.

- ★ **<u>Grade 1</u> Weather**
  - **Class discussion on clothing – colors and fabrics**
  - **Investigation where thermometers are placed in white construction paper envelopes versus those placed in black construction paper envelopes and exposed to sunlight.**

5.2.2.D.1 Predict and confirm the brightness of a light, the volume of sound, or the amount of heat when given the number of batteries, or the size of batteries. (4)

- ★ **<u>Grade 4</u> Magnetism and Electricity: lighting a bulb using parallel and series circuits**

5.4.2.G.4 Identify the natural resources used in the process of making various manufactured products.

- ★ **<u>Grade 1</u> Social Studies – Clothing**
  - **A variety of big books and activities are used to compare artificial clothing, clothing made from animals, and clothing made from plants and the processes involved in each.**
- ★ **<u>Grade 4</u> Earth Materials: Identifying objects that are made of rocks and minerals.**

5.3.4.A.1 Develop and use evidence-based criteria to determine if an unfamiliar object is living or nonliving.

- ★ **<u>Grade 1</u> From Seed to Plant**
  - **Children are asked to identify what makes an object a "seed", to sort items as "seeds" or "not seeds".**
  - **Children need to recognize what living things need to survive – sort living vs. nonliving pictures.**

5.4.4.A.4 Analyze and evaluate evidence in the form of data tables and photographs to categorize and relate solar system objects (e.g., planets, dwarf planets, moons, asteroids, and comets).

- ★ **Grade 2 Addressed in 2nd grade LA curriculum (specifically in Magic School Bus: Lost in Solar System) as well as in some optional supplemental non-fiction texts.**

5.3.4.C.1 Predict the biotic and abiotic characteristics of an unfamiliar organism's habitat.

- ★ **Grade 5 Minimally addressed in the 5th grade ecosystems unit.**

5.4.4.E.1 Develop a general set of rules to predict temperature changes of Earth materials, such as water, soil, and sand, when placed in the sun and in the shade.

- ★ **Grade 1 Weather**
  - **Puddles – students experiment with colored water and make puddles. Puddles are placed in sun and in the shade and evaporation is recorded.**
  - **Thermometers – placed in sun and shade**
  - **Discussion – real life experiences – i.e. sand at the beach too hot to walk on**

5.3.4.E.1 Model an adaptation to a species that would increase its chances of survival, should the environment become wetter, dryer, warmer, or colder over time.

- ★ **Grade 5 Minimally addressed in the 5th grade social studies curriculum; addressed more substantially in the 5th grade ecosystems unit.**

5.3.4.E.2 Evaluate similar populations in an ecosystem with regard to their ability to thrive and grow.

- ★ **Grade 5 Addressed in the 5th grade ecosystems unit**

5.2.4.E.4 Investigate, construct, and generalize rules for the effect that the force of gravity has on balls of different sizes and weights.

- ★ **Grade 1 Balance and Motion**
  - **Creating ramps and roller coasters**

  (Supplemental – an experiment where students drop large and small marbles and rubber balls into a tray of sand and measure "craters")
- ★ **Grade 4 Motion & Design: falling weight system (washers of different sizes and weights)**

Elementary Science Curricula

The elementary science offerings are designed to cover the full scope of science standards by rotating between the various branches of science. Kits are progressively more difficult in content as students advance through the grades, but the primary goal of the kits is to engage students in the scientific process using a hands-on inquiry approach. Through this method, content is encountered as it is needed for a particular experiment instead of in isolation, disconnected from the scientific process.

Grade	Kit 1	Kit 2	Kit 3
Kindergarten	Myself and Others Insights	Trees FOSS	Life Cycle of the Butterfly STC
1st	Weather STC	Balance and Motion FOSS	From Seed to Plant Delta
2nd	Insects FOSS	Changes STC	Sun, Moon, & Stars FOSS
3rd	Human Body FOSS	Chemical Tests STC	Ideas and Inventions FOSS
4th	Earth Materials FOSS	Magnetism & Electricity FOSS	Motion and Design STC
5th	Variables FOSS	Microworlds STC	Ecosystems STC

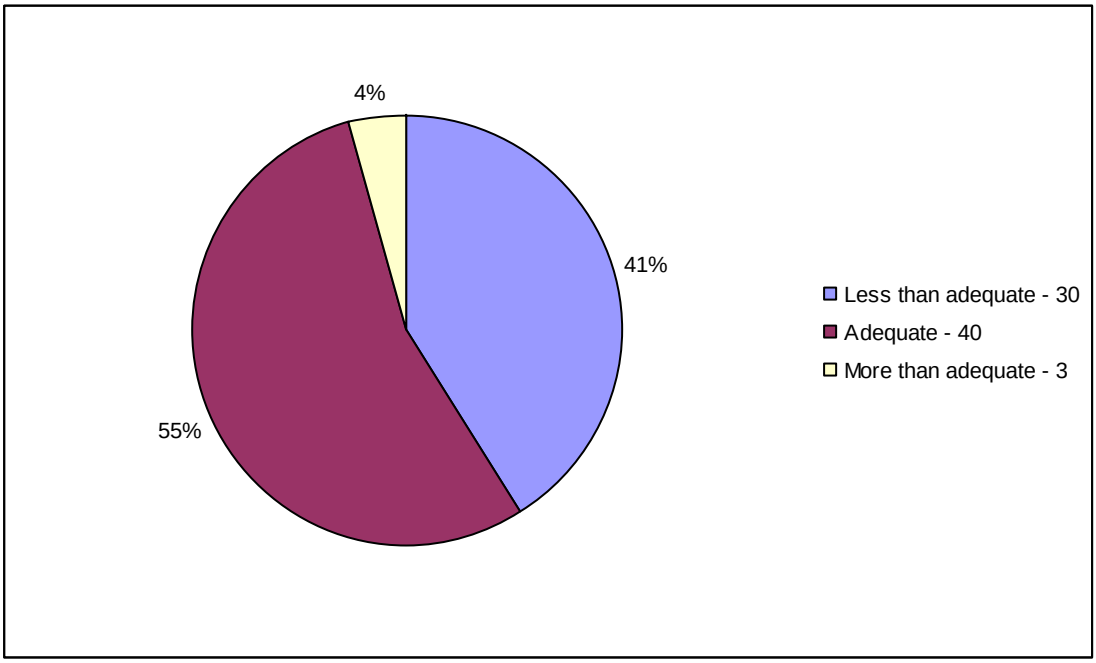
Perception of the Program

During the course of the program evaluation, a survey was created by the committee to measure the elementary staff's perception of the K-5 science program. This survey was then distributed to staff in the winter of 2011 using Google Forms. The data below represents the feedback from 73 K-5 staff members.

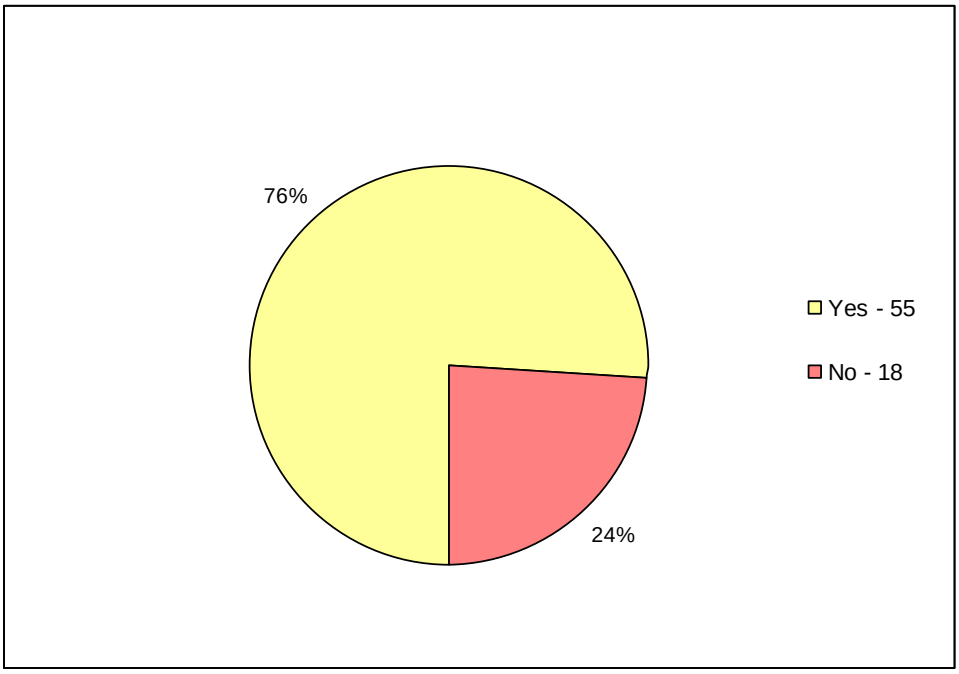
73 responses

Summary

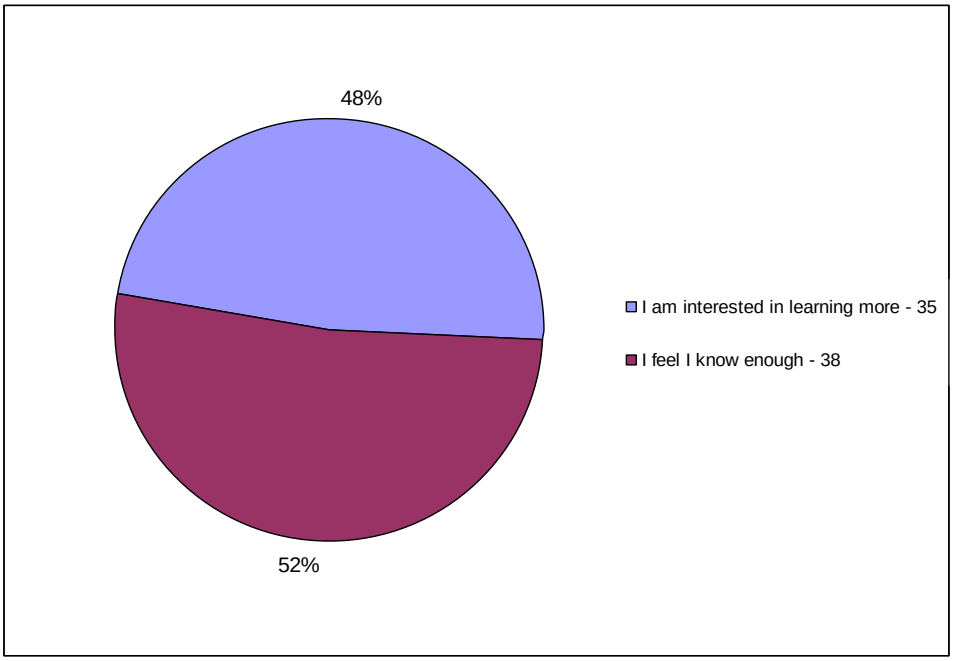
1. How do you feel about the amount of professional development that has been delivered in science?



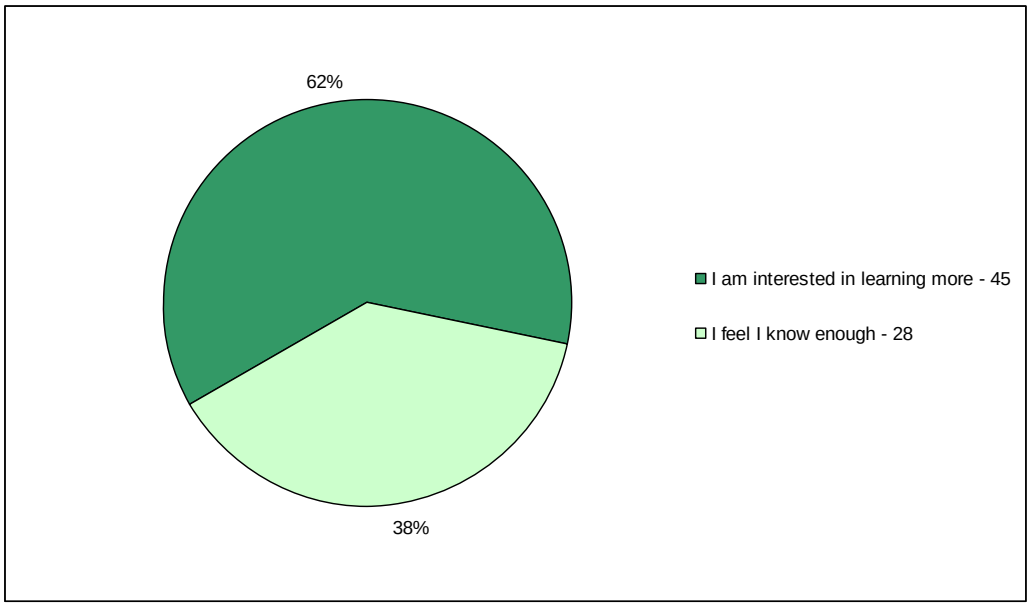
2. Would you benefit from additional professional development in the area of inquiry based science?



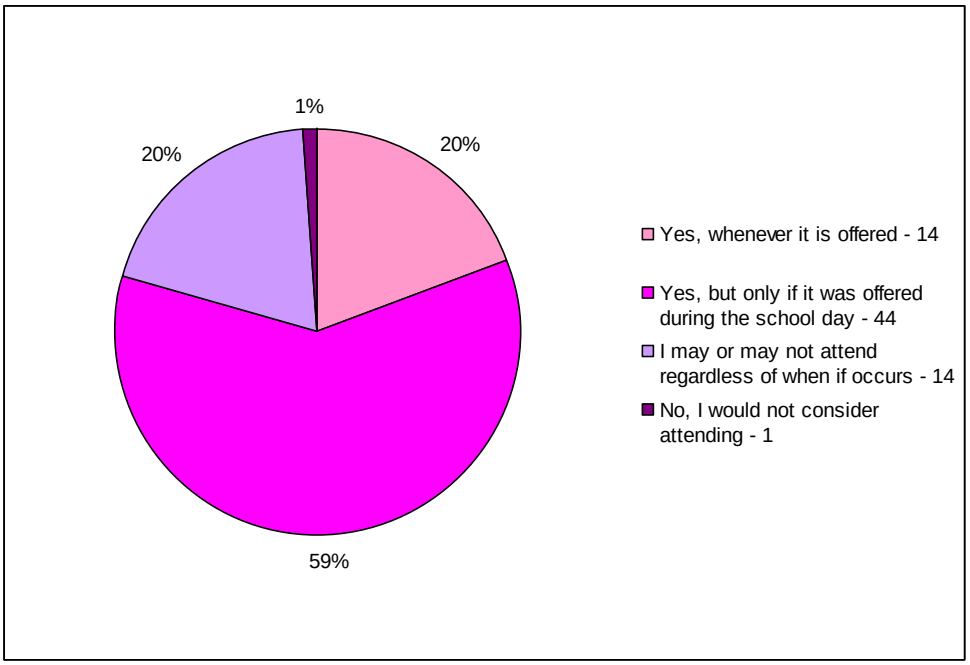
3. How would you describe your understanding of the science content you teach?



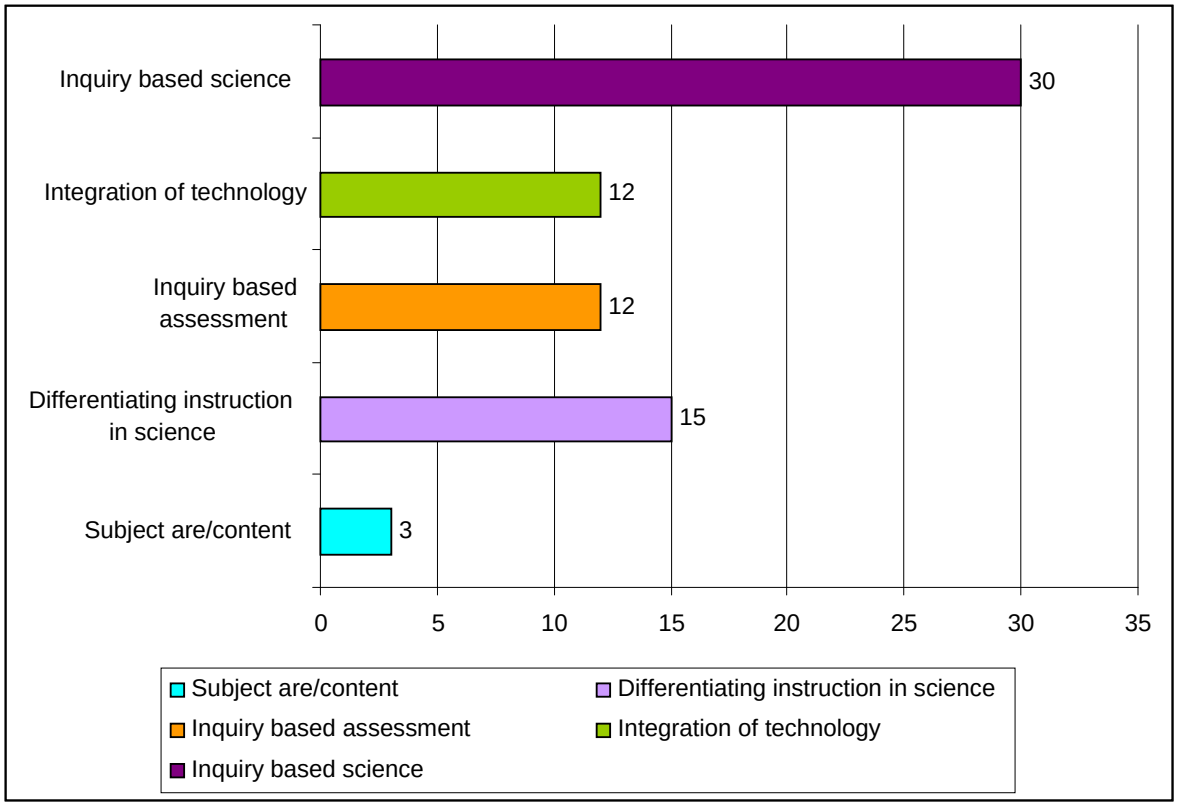
4. How would you describe your understanding of the inquiry based science and assessment?



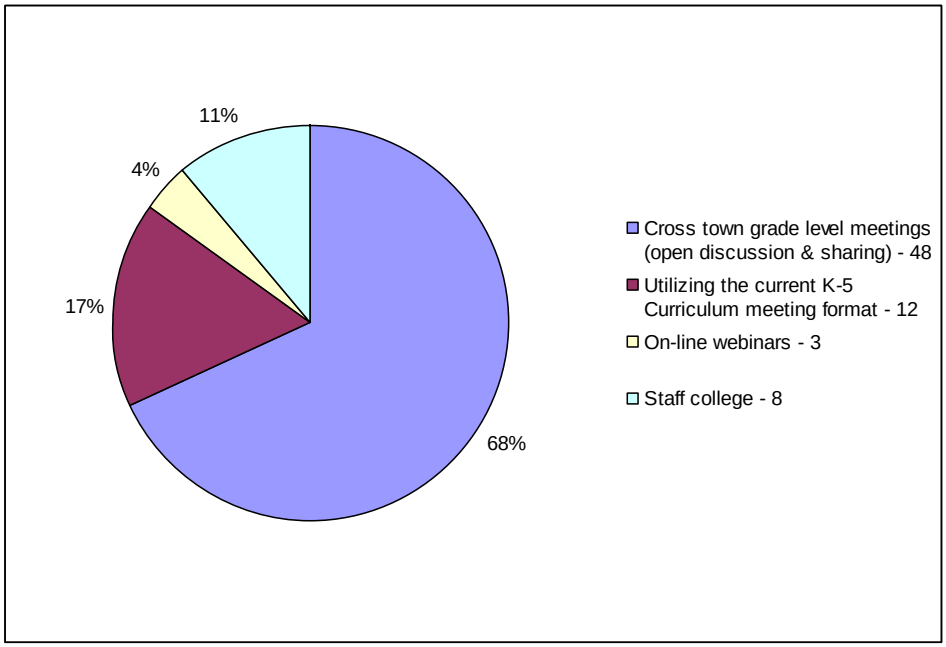
5. Would you benefit from additional professional development in the area of inquiry based science?



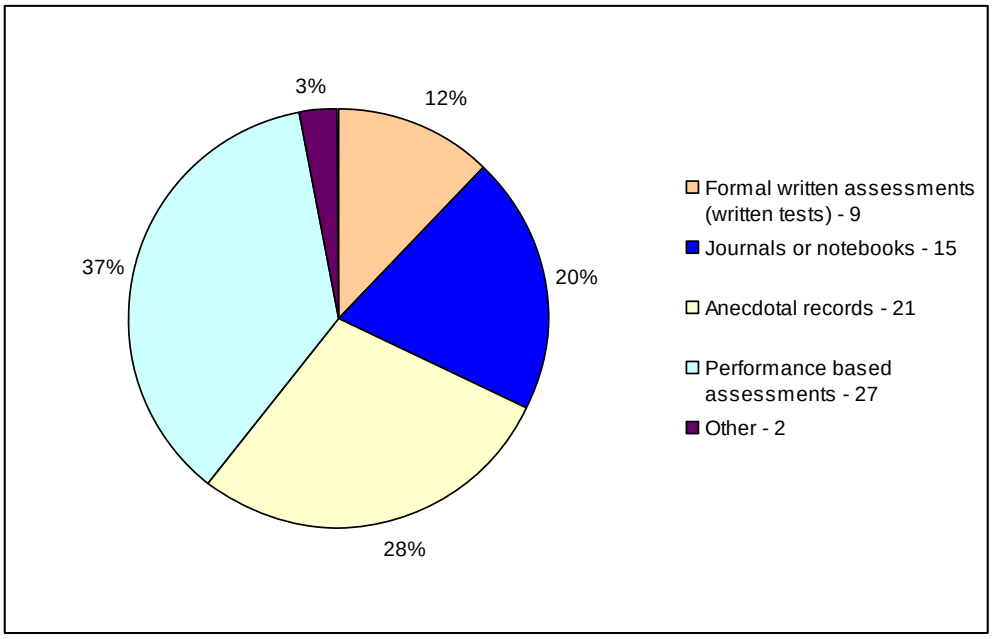
6. Which of the following would you be most likely to attend if offered (select one)?



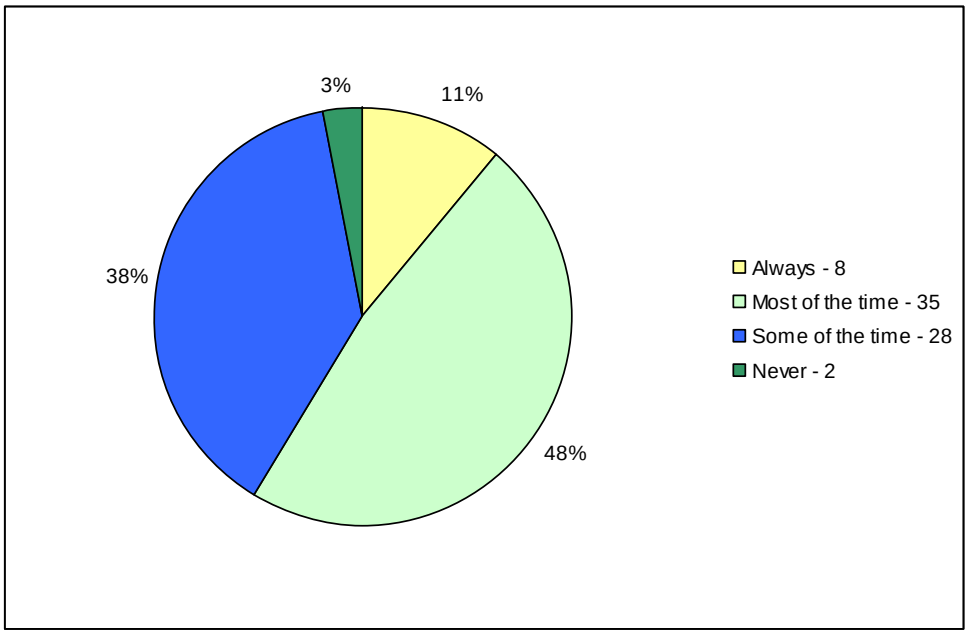
7. What type of professional development on inquiry based science kits would you most like to see implemented? (select one)



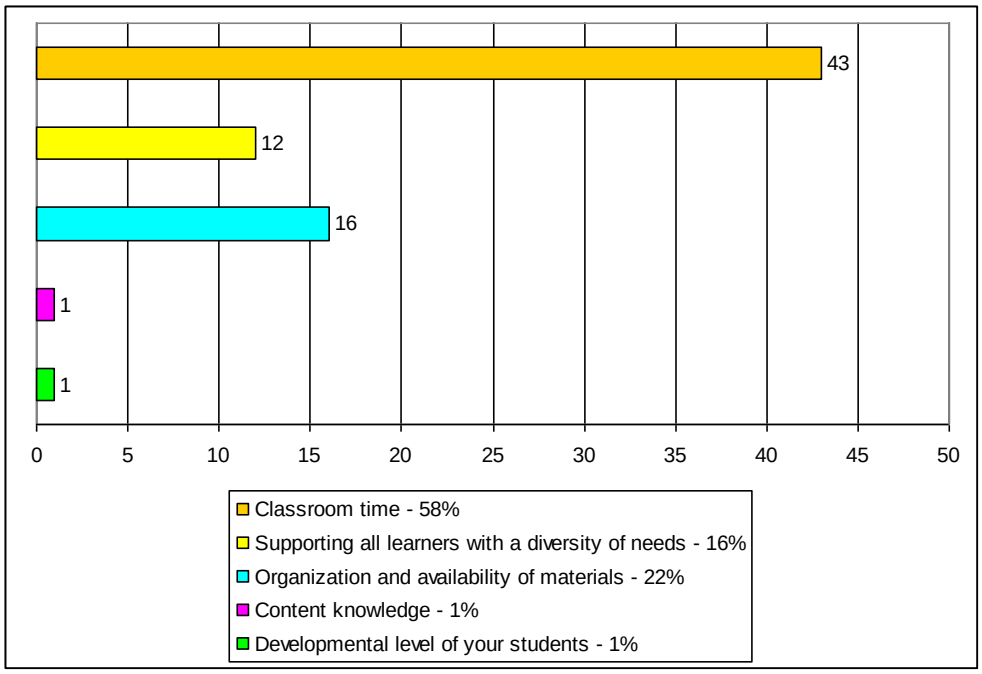
8. On your grade level, what type of assessment do you feel is most effective when evaluating your students' science knowledge? (select one)



9. Do you feel that the assessments currently in place provide you with the necessary information you need to evaluate your students' progress in science for their report card?



10. What is the most pressing obstacle that impacts your delivery of the science curriculum?



Survey Analysis

The first two questions on the survey reveal that while the majority of K-5 staff feel the professional development for inquiry based science has been adequate, there are still many staff members who do not feel effectively prepared in science. The second question showed that the majority of staff members would welcome more training in this area. While training has been done with staff on the various kits, the training has not been ongoing and hence new staff members are not necessarily exposed to the various kits through a professional development experience and instead rely on their grade level team members to assist them with mastering the investigations.

The next two questions showed that the staff is evenly split in their level of understanding in the content area, but more staff would welcome further professional development in the area of inquiry based science. In question five, 58 out of 73 staff members stated that they would be interested in more training if it were to take place during the school day, but only a small percentage would be willing to attend if it was offered after school hours. With the current staff college requirements there are many courses competing for the staff member's interest and therefore it is more difficult to rely on this model if specific training is called for. In the past, science kit training occurred during pull out training sessions.

The next question showed strong support for further professional development in inquiry based science with 30 staff members selecting this option as they would be most likely to attend. Question seven built on this and identified cross-town meetings as the delivery method of choice for further professional development in science. This supports general anecdotal discussion regarding the topic. While Staff College serves as a flexible and useful tool for the specific growth of an individual, large scale training and professional development should be the same across the district. To achieve this, the district must ensure all staff receives the needed professional development in a consistent manner across all buildings.

When asked questions regarding assessments, staff members gave mixed results when determining the most useful assessments for science. The majority of staff agreed that performance based assessments and anecdotal records were more useful than formal written assessments. Following up on this, question eight revealed that most staff feel they have access to assessments that allow them to evaluate and quantify their students' progress in a way that can be detailed on a report card. With a wide variety of kits selected across multiple grade levels it is difficult to determine what units may need more assessments integrated into the investigations. This question will require follow up at district curriculum meetings.

The final question dealt with the obstacles that a teacher may face with implementing the science program. The survey included several options that have been gathered since the start of the review as anecdotal information. The committee agreed that these topics represent most of the difficulties with the program. The major obstacle, according to 58% of surveyed staff, is the lack of classroom time for instruction. The amount of time available for science instruction is small compared to the time allocated to language arts and mathematics. Because of this, teachers often state that it is difficult to complete all three kits in their entirety with the limited time available.

Program Comparisons

Montgomery
Kit based inquiry science program
K – Senses, Myself and Others, Balls and Ramps
1 – Organisms, Sunshine and Shadows
2 – Solids and Liquids, Astronomy
3 – Electricity and Magnetism, Plant Growth and Development
4 – You and your Body, Weather: An Earth System, Motion and Design
5 – Mixtures and Solutions, Floating and Sinking, Microworlds, Ecosystems

Chatham
Mixed program at each grade level.
Detailed access to curriculum not available

Westfield
Mixed program at each grade level.
1 - Life Science unit - plants, animals, and ecology
Physical Science unit - matter and energy
Earth Science unit - weather and space
Human Biology unit - basic growth and senses

2 - Life Science unit - plants, animals, and ecology
Physical Science unit - matter and energy
Earth Science unit - earth materials
Human Biology unit - describes how the body works and ways to keep the body healthy

3 - Life Science unit - plants, animals, and ecology
Physical Science unit - matter and energy
Earth Science unit - rocks and minerals
Human Biology unit - skeletal and muscular systems

4 - Life Science unit - plants, animals, and ecology
Physical Science unit - matter and energy
Earth Science unit - water
Human Biology unit - digestion and circulation, the brain and sense organs

5 - Life Science unit - plants, animals, and ecology
Physical Science unit - matter and energy
Earth Science unit - waters and landforms
Human Biology unit - skeletal, muscular, respiratory, and excretory

Princeton (Note: separate teachers for elementary science)
K- Seed/Plant Growth, Life Cycles, Animals, Properties of Matter, Weather
1 – Plants, Light and Shadows, Matter, Animals
2 – Weather and Climate, Behavior and life cycle of animals, Magnetism, Rocks and Soil
3 – Oceanography, Simple machines, Astronomy
4 – Oceans: Structure and Communities, Changing surfaces of earth, Magnetism, Electricity
5 – Plants, Ecosystems, Wetlands Weather

Hillsborough

Inquiry based program
K- Thematic units – Non-fiction age-appropriate books for teachers/students (½ day K program)
1 – STC Changes – (solids, liquids, gasses); STC Weather kit; STC Organisms kit with soils supplemental units
2 –Force, Motion and Energy unit; Fossils study; Rainforest adaptations unit; STC Life Cycle of Butterflies kit
3 – STC Rocks & Minerals kit; Sun, Moon, Earth unit; Energy unit
4 – Weather unit; Water unit; Life Science unit
5 – Ecosystems, Microworlds, Electric Circuits

The Merck State Science Partnership

Supports the use of inquiry based science kits K-5. The most commonly used kits are:
K – Wood and Paper, Trees, Senses, Animals 2x2
1 – Solids and Liquids, New Plants, Organisms, Weather
2 – Air and Weather, Insects, Soils, Life Cycle of the Butterfly, Changes, Balancing and Weighing
3 – Structures of Life, Measurement, Water, Magnetism and Electricity
4 – Human Body, Sun, Moon, and Stars, Land and Water
5 – Mixtures and Solutions, Environments, Motion and Design

NJ ASK Test Data

NJ ASK 4 Science (2011)

	Percent at or Above State Standards		Mean Scale Score	
Student Population	**Bernards**	**DFG J**	**Bernards**	**DFG J**
Science (Total Students)	97.0	97.8	259.4	261.8
Science (GE)	98.6	99.2	263.0	265.8
Science (SE)	91.1	91.6	245.1	244.1

NJ ASK 4 Science - Percent At or Above State Standards by Gender

Student Population	Male	Female
Science (Total Students)	96.4	97.6

NJ ASK 4 Science – District Mean Scale Scores By Year

Student Population	2008	2009	2010	2011
Science (Total Students)	247.0	252.7	248.6	259.4
Science (GE)	250.9	254.7	249.8	263.0
Science (SE)	231.7	241.6	243.1	245.1

NJ ASK 4 Science - District Mean Scale Scores By Subgroup*

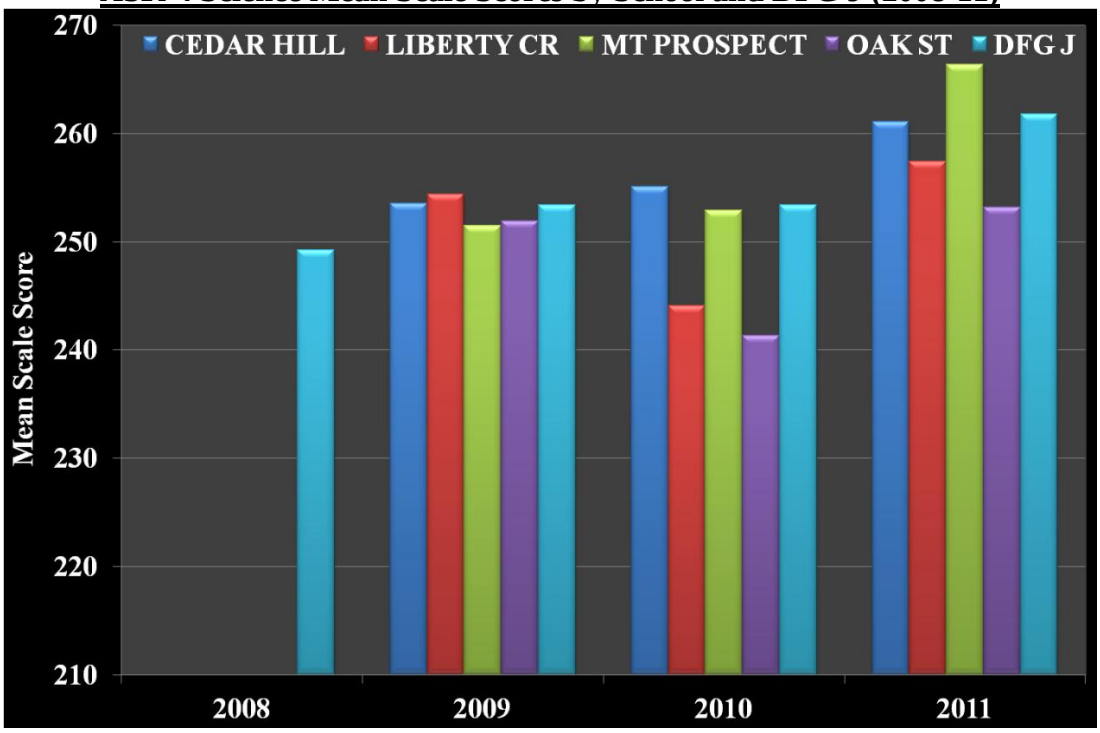
Student Population	Male	Female	Asian	White
Science (Total Students)	261.8	256.9	276.9	255.6

*Only reported for subgroups with n>40

NJ ASK 4 Science - Mean Scale Scores by School

	OS	CH	LC	MP
Science (Total Students)	253.2	261.1	257.4	266.4
Science (GE)	257.9	265.8	259.7	268.6
Science (SE)	238.5	241.8	249.9	254.1

ASK-4 Science Mean Scale Scores by School and DFG J (2008-11)



Goals/Recommendations

Based on focused discussions during committee meetings, results of the staff survey, national and state curriculum changes, and anecdotal data from staff and students, the following goals were agreed to by the program evaluation committee. Proposed solutions are offered and attempt to identify the ideal solution as well as alternatives that, in conjunction with other changes, may serve to meet the goal and solve the problem.

Goal 1

Increase the amount of Nonfiction Literature at differentiated levels for students to use as supplemental materials.

Problem

The students have difficulty working with informational text in literature which will impact state test scores. There is currently not enough exposure to this literature across the curriculum.

Support

- NJASK Scores
- National and State Curriculum Changes (Common Core and Next Gen Standards)
- Findings of Science Evaluation/Review Committee Members

Proposed Solutions

- Purchase Differentiated Non-Fiction Literature Materials in Language Arts which helps to manage time in covering required curriculum across all areas.
    - Allow teachers to give input on the literature to be purchased based on their expertise within their curriculum.
    - LA and Science Supervisors attain sample copies for staff to review and make decisions on what should be purchased.
- In line with the upcoming Language Arts standards changes, purchase of theme-related informational texts (big books, class sets, teacher read alouds, Guided Reading sets)

Goal 2

Decrease the amount of instructional material required to cover during the content block.

Problem

In this set block of time, faculty are required to cover curriculum including Science, Social Studies, Health, Latin, DARE, Character Education, Monthly Assemblies, and OLWEUS (Bullying Meetings).

Support

Survey Question #10 on the Science Survey results indicates that 43/73 or 58% of people feel that the lack of available time impacts their ability to implement content instruction.

Proposed Solutions

- Common Planning Time - Departmentalized Teaching (ex. an expert science teacher)
- Reevaluate content curriculum in K-5 overall to be sure it still aligns with the current standards and curriculum guidelines.

Goal 3
Increase Professional Development in Inquiry Based Science.

Problem
There is a lack of time and district funding for substitutes and outside professional development for pull-out training.

Support
- Survey Question #7 on the Science Survey results indicates that 48/73 (66%) people who answered the survey feel that there is a need for cross town grade level meetings (open-discussion and sharing).
- Survey Questions #2 and #4 also indicate that faculty would benefit from additional professional development in the area of inquiry based science.

Proposed Solutions
- Common Planning Time - Departmentalized Teaching (ex. an expert science teacher)
- Implement half-days for teacher in-service training in these specific areas.
- AP teachers/students to instruct in each grade level's themes.
- Utilize K-5 curriculum meeting times for cross town grade level discussions in an open forum format
- Offer additional staff college courses in grade level specific content knowledge
- Have AP students create online tutorials for grade level specific content knowledge
- Identify "science mentors" on each grade level to share suggestions with their teams

Goal 4
Increase set-up space and time.

Problem
There is a lack of classroom space and instructional time to deliver the mandated curriculum.

Support
Survey Question #10 on the Science Survey results indicates that 43/73 or 58% of people feel that the lack of available prep time and space impacts their ability to implement content instruction.

Proposed Solutions
- Common Planning Time - Departmentalized Teaching (ex. an expert science teacher)
- Using the Café, Gym, and/or Classroom for the Expert Science Teachers in all grade levels to setup and instruct ALL students.
- Release time for one teacher to setup all classrooms for the next science lesson.