

Promoting Scientific Inquiry Through Innovative Science & Engineering Curricula in Grades 3-5

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NJ Math-Science Partnership



- Stevens Institute of Technology
Montclair State University
The College of New Jersey
Liberty Science Center
- 47 Grade 3-5 teachers in
18 public and 3 non-public schools
Northern New Jersey
- 2nd year of the 3-year project



Goals

- Increase teachers' content knowledge in science & engineering
- Improve teachers' notions of scientific inquiry
- Improve teachers' pedagogical knowledge in creating & adopting science inquiry & engineering lessons
- Increase students' content knowledge in science & engineering (Grades 3-5)

Focus

Year 1: Life Science 2007-08
Environmental Science

Year 2: Earth Science 2008-09
Space Science

Year 3: Physical Science 2009-10

Technological literacy throughout





Overview of Findings in Year 1

- Presented at the ASEE's Mid-Atlantic Conference, Hoboken, NJ, October 2008
- 57 teachers & 555 students (treatment group)
- Content knowledge (science and engineering) of treatment teachers increased by 1.91 points or 7.6 percentage points.
- Content knowledge of students in the treatment group is 2.5 times greater than the students in the comparison group

Program Structure

- Intensive two-week summer institute
- 3 professional development workshops during the school year
- Monthly classroom visits



Summer Institute Content

- Science lessons with focus on scientific inquiry
- EiE curricula
- CIESE Internet-based real time data and telecollaborative projects
- Faculty presentations, lab tours, workshops & hands-on activities



EiE Modules

- Developed by the Museum of Science, Boston
- Integrate elementary science topics with a specific field of engineering
- Feature hands-on activities
- Engage students in the engineering design process



EiE *Catching the Wind*: Testing a Windmill





Local Geology “Rock Walk”



Designing a Wall



Engineering is Elementary

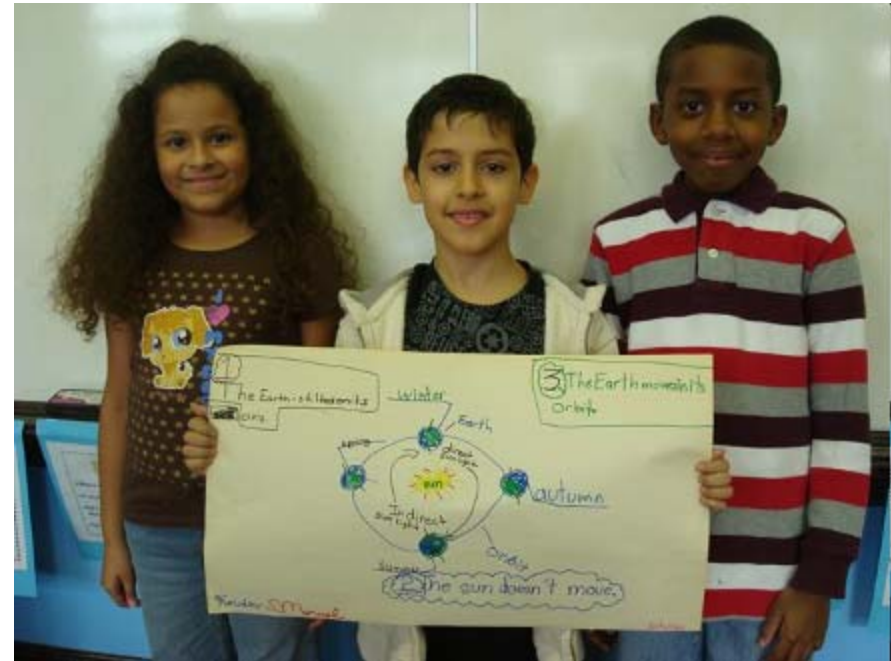
- Grade 3, Jersey City, Testing Walls
- Movie





What Causes the Seasons?

Science Inquiry Models





Data Sources

- Teachers' notions of inquiry
 - Pre-survey
 - End of the workshop survey
 - Teacher-developed learning module
 - Classroom artifacts



Findings

- Almost 50% of teachers described their classroom to be “somewhat” inquiry-based.
- There was no correlation between the teachers’ years of teaching experience and their ratings of their classrooms as inquiry-based.
- Majority of teachers felt that they need to change the way they teach to make their classroom more inquiry-based

Source of the inquiry question

Source of Inquiry Question	Survey #1	Survey #2
Teacher generates question (guided inquiry)	6%	17%
Student generates question (independent inquiry)	33%	15%
Both guided and independent inquiry	4%	6%
Unspecified who generates question	24%	34%
Implies a question	8%	4%
No question	24%	23%

Process of Scientific Inquiry (1st Survey)

Coding Scheme	Count	Percent (n=49)
Students generate naïve models (A)	7	14%
Students develop hypotheses to test experiments (B)	16	33%
Students conduct a series of observations or experiments, using different techniques or approaches (C)	26	53%
Students analyze the data (D)	2	4%
Students explain results based on science (E)	2	4%
Students revise models (F)	0	0%
Students present consensus model (G)	0	0%
Students conduct additional experiments (H)	0	0%
Students further revise the model (I)	0	0%
Students present final model (J)	0	0%

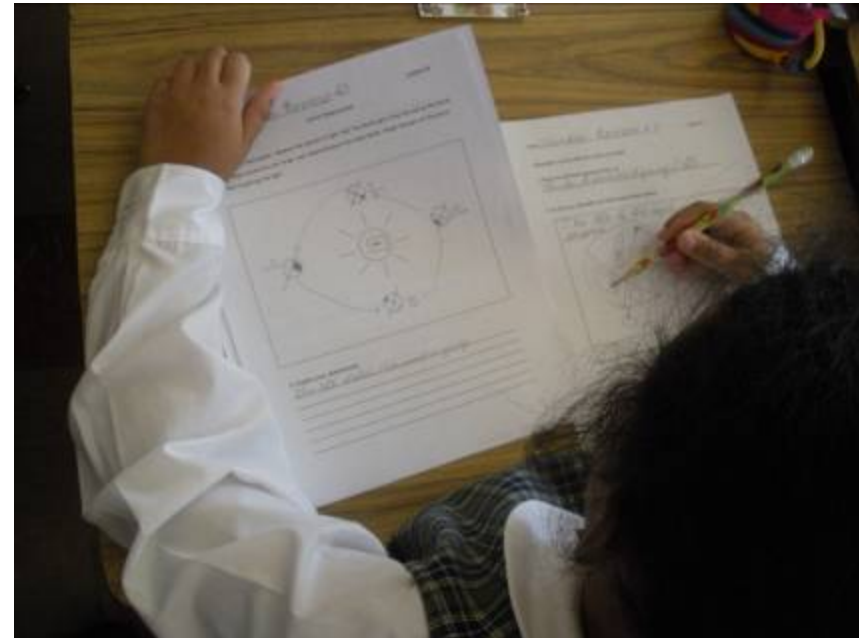
Process of Scientific Inquiry (2nd Survey)

Coding Scheme	Count	Percent
Students generate naïve models (initial conceptions) (A)	25	53%
Students develop hypotheses to test experiments (B)	4	9%
Students plan investigation (C)	4	9%
Students conduct a series of observations or experiments, using different techniques or approaches (D)	39	83%
Students analyze data (E)	7	15%
Students explain results based on science (F)	11	23%
Students revise their models based on data (G)	20	42%
Students present consensus model (H)	10	21%
Students conduct additional experiments (I)	4	9%
Students further revise the model (J)	3	6%
Students present final model (K)	1	2%

Teachers' Impediments to Ideal Science Teaching

- Student Population
 - Students of different ability-levels
 - Behavioral & discipline problems
 - Not used to scientific inquiry
 - Lack of collaborative working skills
 - Special education needs
 - Class size
 - Lack of parental support
- Time & test prep issues
- Resources
- Curriculum-related challenges
- Policy and/or Leadership expectations

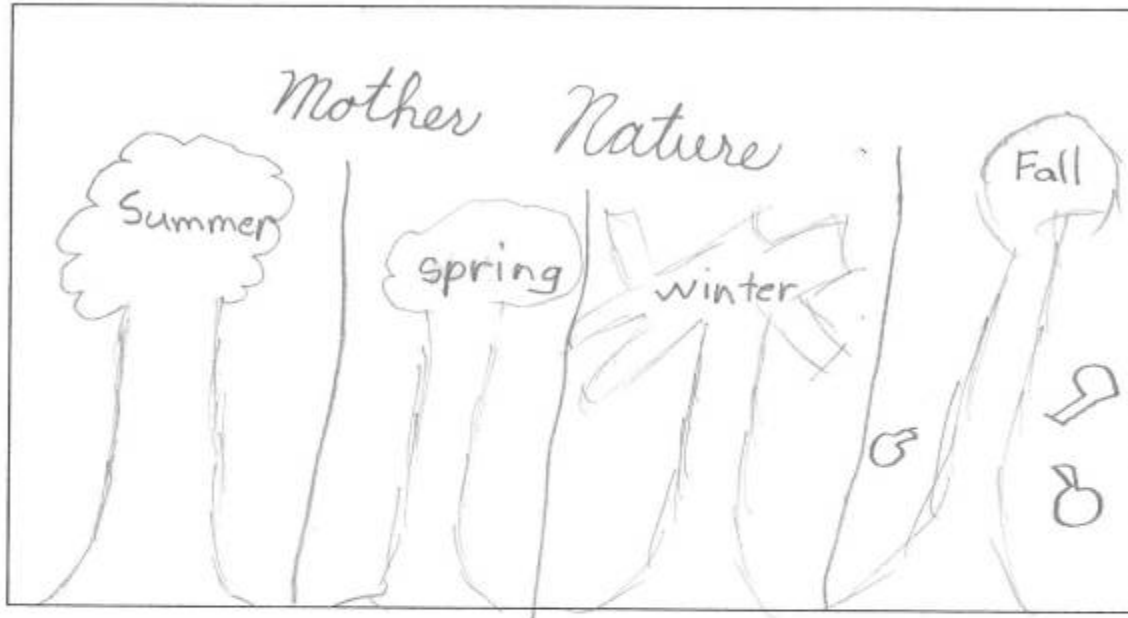
Samples of Student Work in Model-based Inquiry



Reasons for Seasons – 3rd Grade

Level 0- No, little, or incorrect understanding

2. In the box, draw what you think causes these seasons.



**Naïve Model -
Student E**

3. Why do you think we have seasons? Explain.

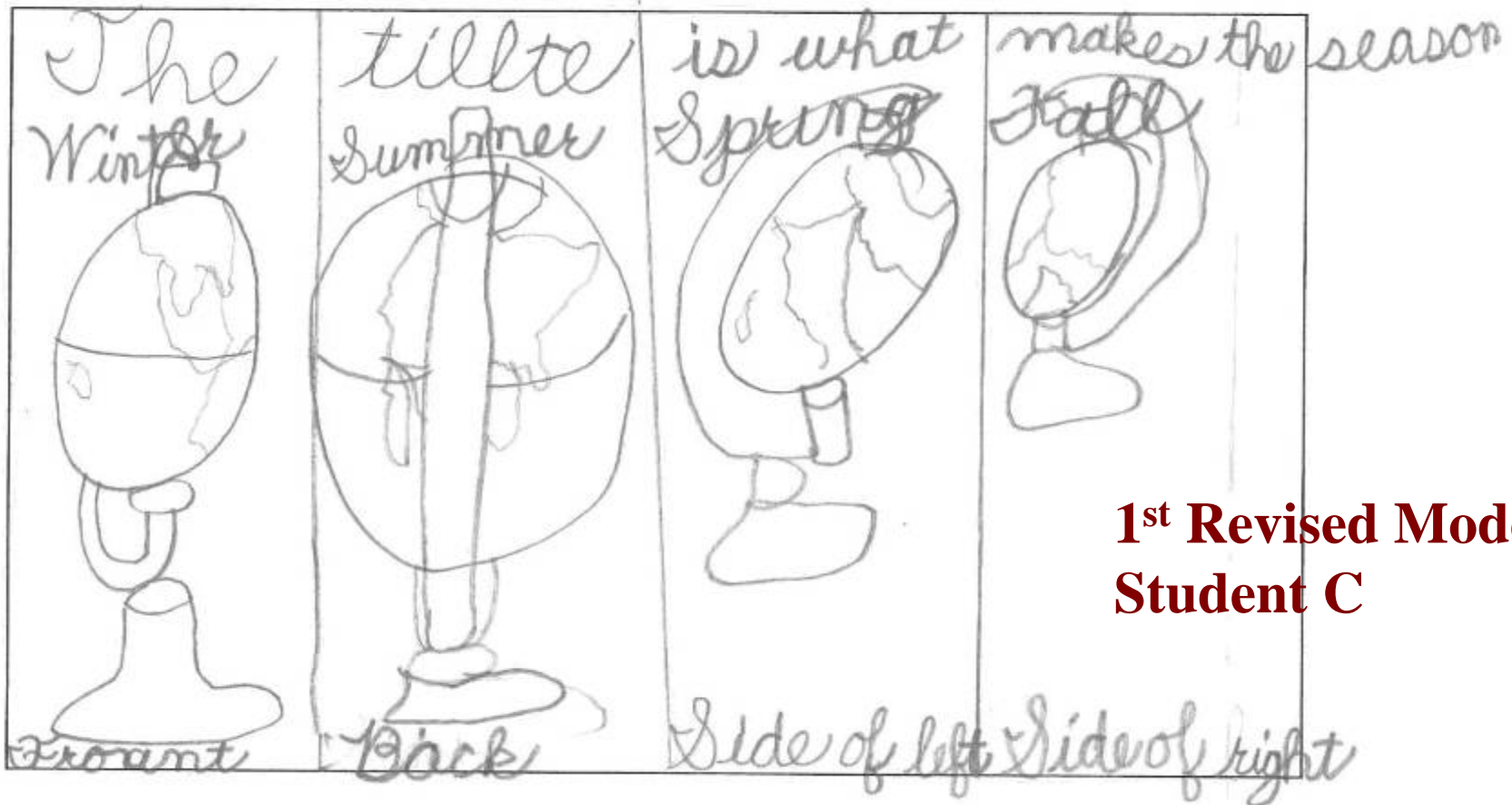
I think we have seasons because we live on a different continent and if you go somewhere else it might be a different climate.

4. How do you know that?

I looked it up on the computer.

Level 1 - Some understanding. The student can make a diagram/representation but can't explain or has incorrect explanation

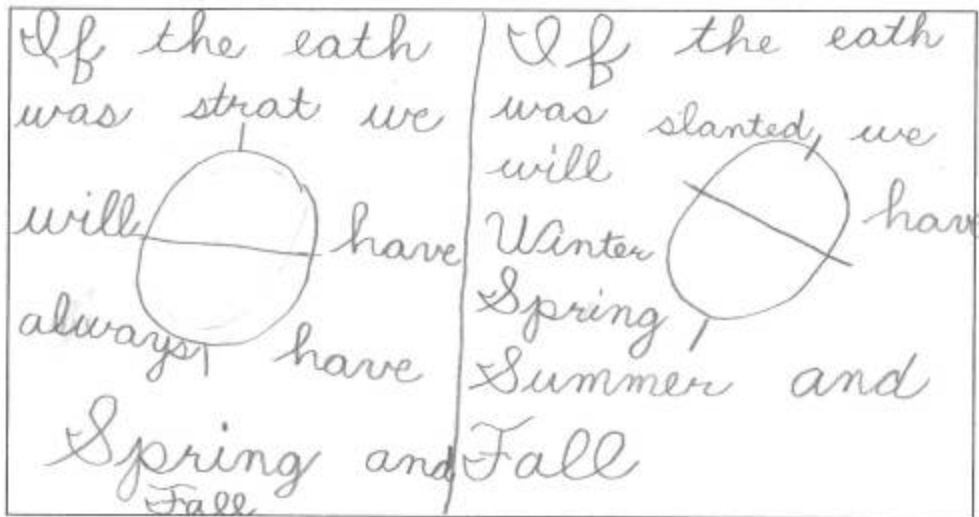
2. In the box, draw what you think causes these seasons.



**1st Revised Model-
Student C**

Level 2- Better understanding. Student can identify the parts of the model but can't make connections (diagram/representation and explanation)

2. In the box, draw what you think causes these seasons.



**1st Revised Model-
Student A**

3. Why do you think we have seasons? Explain.

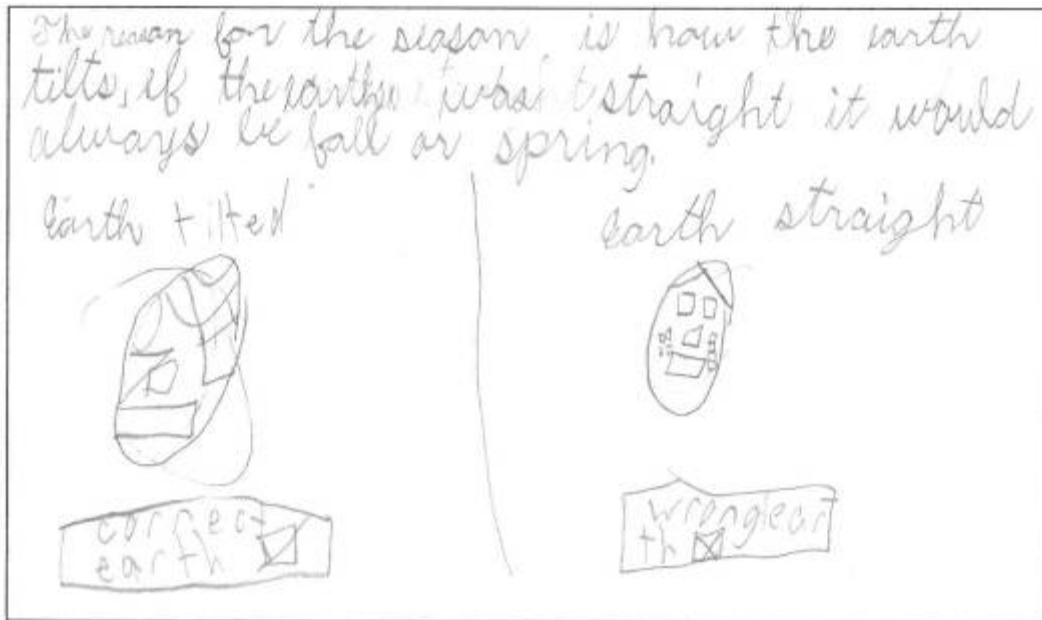
The tilt makes the seasons.

4. How do you know that?

When the eath is strat we will have always Spring and Fall. When the eath is slanted we will have Winter, Spring, Summer, Fall.

Level 3- Accepted Model & Explanation

2. In the box, draw what you think causes these seasons.



**1st revised
model -
Student Z**

3. Why do you think we have seasons? Explain.

I think we have seasons because of the sun and earth's tilt. I think that because when the sun is fading the northern hemisphere it is now summer.

4. How do you know that?

I learned that when someone taught me.



Model-based Inquiry Results

- Beginning of the lesson
 - 27 students are at Level 0
 - 2 students are at Level 1
- After the first lesson
 - 7 students remained at Level 0
 - 19 students moved from Level 0 to 1
 - 1 moved from Level 0 to 2
 - 1 moved from Level 0 to 3
 - 2 students remained at Level 1

For More Information



The screenshot shows the PISA website interface. At the top, there is a green banner with the text "PISA Partnership to Improve Student Achievement" and a background image of students. Below the banner is a navigation menu with buttons for Home, Teachers, Workshops, Resources, Listserv, Learning Modules, Highlights, and Contacts. The main content area is titled "Overview" and contains three paragraphs of text. The first paragraph describes the partnership of 68 teachers from 24 schools from the districts of Bayonne, Hoboken, Jersey City, Newark, Piscataway, Weehawken, and two non-public schools, together with Stevens Institute of Technology, Montclair State University, and Liberty Science Center. The second paragraph describes an intensive, two-week summer institute. The third paragraph describes three professional development days and monthly classroom visits. At the bottom left of the screenshot, there are logos for Stevens Institute of Technology and the State of New Jersey Department of Education.

PISA
Partnership to Improve Student Achievement

Home
Teachers
Workshops
Resources
Listserv
Learning Modules
Highlights
Contacts

Overview

A partnership of 68 teachers from 24 schools from the districts of Bayonne, Hoboken, Jersey City, Newark, Piscataway, Weehawken, and two non-public schools, together with Stevens Institute of Technology, Montclair State University, and Liberty Science Center, will provide teams of teachers with deeper science content knowledge, research-based professional development, and experience with innovative science and engineering curricula and materials for Grades 3-5. The Boston Museum of Science's National Center for Technological Literacy and Bank Street College of Education are also partners in this collaboration. Teachers will participate in a dynamic and supportive learning community designed to address topics in key content areas in Grades 3-5 science, engineering, and technology education. Year 1 activities will focus on New Jersey Core Curriculum Content Standards 5.5 and 5.10 (life and environmental sciences) and 8.2 (technology education).

An intensive, two-week summer institute will involve teachers in collaborative learning through engagement in science inquiry, engineering design, foundational learning in core science topics, and the development of a Science Technology Engineering Mathematics Learning Module (STEM Learning Module) that introduces topics in science through inquiry-based activities and use of the engineering design process. Teams will work together on developing the module, including identification of student science learning objectives (tied to the district science curriculum and the NJCCCS), lesson plans, implementation and classroom management plans, and student assessments.

Three professional development days during the school year and monthly classroom visits will support teachers as they implement content and materials during the school year.

Assessment of student and teacher learning will take place, within participating classrooms and in comparison classrooms.

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www.stevens.edu/ciese/pisa

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