NORTHBROOK SCHOOL DISTRICT 27

SCIENCE CURRICULUM

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Educating Students to Succeed in a Changing World

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Overview

Northbrook School District 27 has developed a rigorous science curriculum built on essential questions, Project 2061 learning goals, formative and summative assessments, and research on effective teaching and learning practices. Following recommendations by Project 2061, the highest authority on science teaching, learning and reform, District 27 carefully created units of study at each grade level that are developmentally appropriate and focused on central learning goals and skills. The resulting product is a recursive curriculum that attends to students' existing ideas, provides authentic science experiences, encourages science exploration, and builds science literacy.

District 27 has created a unique electronic curriculum product that supports teachers' learning and on-going implementation of the curriculum. The dynamic electronic curriculum includes video clips to support teachers, extensive samples of student work, comprehensive tips for teachers, files that support instructional differentiation, and numerous assessments.

This white paper describes the goals and process used for the development of District 27's science curriculum. Units of study are outlined, and commercial resources used to teach the units are listed. District curriculum documents are explained, and samples from the electronic curriculum are included.

Theoretical Framework

Project 2061 by the American Association for the Advancement of Science and the Illinois Learning Standards provides the theoretical framework for the new science curriculum. Project 2061 publications such as *Science for All Americans, Benchmarks for Science Literacy, Designs for Science Literacy and Atlas for Science Literacy* have been used extensively in the formulation and development of the curriculum.

Goal

The goal of Northbrook School District 27's K-8 science program is to increase science literacy within all students. According to Project 2061, science literacy requires understandings and habits of mind that enable citizens to:

- grasp what those enterprises are up to;
- make some sense of how the natural and designed worlds work;
- think critically and independently;
- recognize and weigh alternative explanations of events and design trade-offs; and
- deal sensibly with problems that involve evidence, numbers, patterns, logical arguments, and uncertainties (AAAS, 1993, p. xi).

To meet the goal of increasing science literacy, Northbrook School District 27 created a rigorous, coherent, and developmentally appropriate science curriculum based on standards and research by Project 2061.

Rationale

The common core of learning to be achieved through this curriculum is designed to provide a foundation upon which additional knowledge can be acquired throughout one's lifetime. Concepts deemed important today and believed important for tomorrow comprise the curriculum. The essential concepts and skills contained in the curriculum meet the criteria of having significant value and utility. According to Project 2061, this common core of learning should provide students with a foundation for

- improving their long-term employment prospects, along with the quality of the nation's workforce, and providing a base for some student to go on to specialize in science, mathematics, or technology or in related fields;
- assisting them in making personal, social, and political decisions;
- acquainting them with ideas that are so significant in the history of ideas or so pervasive in our culture as to be necessary for understanding that history and culture; and
- enhancing the experiences of their student years, a time in life that is important in its own right (AAAS, 2001, pp. 48-49).

Unit Development

Using the learning goals outlined in *Benchmarks for Science Literacy*, the goals were clustered into grade level units. Resources and science kits from five publishers were selected to be used as vehicles for teaching the identified unit learning goals. For some units, multiple resources are utilized. Each lesson within each commercial resource was analyzed using the following criteria:

(1) the lesson must address the unit goals and build understanding of essential concepts and skills;
(2) it must be developmentally appropriate;
(3) the amount of time to teach the lesson must be considered reasonable;
(4) the lesson must be effective in facilitating student learning of the unit goals; and
(5) the lesson/experiment must work and be manageable to teach in the classroom.

Lessons that met the criteria were retained, and lessons that did not were either modified or eliminated. In cases where the publishers' materials did not address a unit goal, lessons were created.

Units & Commercial Resources/Kits

Commercial kits and resources were purchased for most units. Depending on the unit goals, some or all of the lessons within the kit may be taught. The following tables identify the units taught, resources, and publishers for each grade level.

Grade Level	Name of Unit (District 27)	Name of Resource/Kit	Series	Publisher
1	Weather	Weather	STC	Carolina
	Science in the Toy Box	Science in the Toy Box	Science Anytime (Out of Print)	Harcourt Brace
	Plants and Animals	Organisms	STC	Carolina
		Butterflies	STC	Carolina
2	Astronomy: Observing the Sky	Investigating Objects in the Sky	BSCS Tracs	Kendall Hunt
	Matter: Solids, Liquids and Changes	Changes	STC	Carolina
	Balance and Motion	Balance and Motion	FOSS	Delta
	Sound	Designing Sound Systems	BSCS Tracs	Kendall Hunt
3	Plants	Plant Growth and Development	STC	Carolina
		Soil Science	DSM III	Delta
	Earth's Changes	Investigating the Changing Earth	BSCS Tracs	Kendall Hunt
	Magnetism and Electricity	Magnets	DSM III	Delta
		Electric Circuits	STC	Carolina
	Nutrition	District 27 Created Materials		
4	Matter: Changing Properties and Heat	Investigating Changing Properties	BSCS Tracs	Kendall Hunt
		Investigating Heat and Changes in Materials	BSCS Tracs	Kendall Hunt
	The Living Environment	Environments	SCIS III	Delta
	The Microscopic World	District 27 Created Materials		
5	Astronomy: Relative Position, Motion, and Scale	Planetary Science	FOSS	Delta
		Astronomy	DSM III	Delta
		Solar System	DSM III	Delta
		Project Astro		
		Lenses and Mirrors	DSM III	Delta
	Body Systems	Bones and Skeletons	Insights	Kendall Hunt
		Human Body Systems	Insights	Kendall Hunt

Grade Level	Name of Unit (District 27)	Name of Resource/Kit	Series	Publisher
6	Weather	Catastrophic Events	STC/ MS	Carolina
	Processes that Shape the Surface of the Earth			
	Astronomy: Our Solar System	Earth in Space	STC/MS	Carolina
7	Studying People	Science and Life Issues	SEPUP	Lab-Aids
	Micro-Life			
	Genetics			
	Ecology			
8	Properties of Matter	Properties of Matter	STC/ MS	Carolina
	Energy and Motion	Energy, Machines, and Motion	STC/ MS	Carolina

A "Unit Blueprint" produced by Northbrook School District 27 guides users on what lessons to teach within the kit and the goals of each lesson, which are based on Project 2061 rather than the publishers' goals. A "Unit Blueprint" has been created for every unit and is considered the guiding document for each unit. The commercial kits serve as resources for teaching unit goals and skills. Below is a sample "Unit Blueprint" from the 2nd Grade Astronomy unit.

Lesson	Essential/Unit Questions	Benchmarks/Learning Goals	Assessment	Using Assessments to Monitor Student Learning
Lesson 2:	When can the sun be seen in the sky? When can the moon be seen in the sky? How do the sun, moon, and stars appear to move in the sky?	Pre-assessment of 4A(K-2)#2: The sun can be seen only in the daytime, but the moon can be seen sometimes at night and sometimes during the day. The sun, moon, and stars all appear to move slowly across the sky.	Student drawings of sky throughout story (See directions on page 58 of Teacher's Edition. Use teacher-generated *Lesson 1 Drawing Paper* and *Pre-Unit Assessment Checklist* available under "Teacher Resources" on electronic curriculum.) Click to view sample assessments completed by students.	**Student Drawings:** 7 a.m.: Do students show the sun rising (low in the sky)? Noon: Do students show the sun high in the sky? 7:30 p.m.: Is the sun low in the sky (approaching sunset)? 11 p.m.: Do students exclude a sun from their pictures? Do their pictures include stars? Is there a moon (w/a realistic shape) in 1 or 2 consecutive pictures? If the moon is in 2 pictures, does it have the same shape?

Guiding questions that align with the unit goals were created for each lesson.

Learning goals from *Benchmarks for Science Literacy* were identified for each lesson.

Formative and/or summative assessments were created for every lesson. Throughout many units, samples of work are available for teacher review. Samples contain notes to support teachers.

Reflective questions for teacher use are provided for each lesson. They align with the assessments and lesson goals. Answers to the questions should guide further instruction.

Guiding Philosophies and Pedagogy

The concepts and skills contained in the curriculum address physical, life, earth, and environmental science. Technology and mathematics are embedded within the curriculum, with an emphasis on applying and connecting the disciplines. The new curriculum stresses content depth over content breadth. Content contained in the curriculum is believed essential for meeting the goal of science literacy and held up to the criteria of significance and utility as identified in the rationale.

Curriculum coherence across grade levels has been carefully considered. Learning benchmarks selected for each grade level take into consideration the developmental needs of the student. The concepts contained within the curriculum are a network of interrelated ideas, not a collection of concepts. Concepts and skills build progressively upon one another and act as a foundation for continuous learning. The curriculum takes into account research regarding students' conceptions and misconceptions about scientific concepts and what challenges they may face in learning the concepts at certain grade levels. Consequently, certain topics or concepts have been assigned to later grade levels than typically expected. To promote enduring understanding and reduce the perpetuation of misconceptions, the curriculum de-emphasizes technical vocabulary and only uses it when necessary for understanding and considered developmentally appropriate.

Quality science programs require students *do* science. Scientific inquiry is emphasized throughout the curriculum. Only instructional resources that support active engagement of students were selected for inclusion in the curriculum. Students are provided significant opportunities to use scientific inquiry to explore and explain scientific concepts.

> Inquiry is a multifaceted activity that involves making observations; posing questions; examining books and other sources of information to see what is already known; planning investigations; reviewing what is already known in light of experimental evidence, using tools to gather, analyze, and interpret data; proposing answers, explanations, and predictions; and communicating the results (National Research Council, 1996, p. 23).

While inquiry is emphasized, it is one of multiple instructional methods used to develop students' knowledge, understandings, and skills. Students work extensively with physical models. Cooperative and collaborative work experiences are also highlighted throughout the curriculum, with particular emphasis on understanding the value of sharing findings.

Science instruction has been carefully aligned with essential/unit questions, learning benchmarks, and assessments. Questions provide the framework for a lesson, sequence of lessons, and an entire unit. The essential and unit questions are designed to foster inquiry and interest among students. The alignment of benchmarks, questions, instruction, and assessment provides a foundation for coherent student learning experiences. A critical component of assessment includes student self-reflection. Throughout each unit, students have opportunities to reflect on their learning, skills, attitudes, and beliefs about science. By promoting student reflection, lessons become learning experiences.

Electronic Curriculum Product for Grades 1-5

District 27's curriculum is delivered electronically via CDs. It looks and operates like a web site. The CD operates on PCs and Apple computers. An Internet browser such as Internet Explorer or Safari is required. Internet connectivity is not required for accessing curriculum resources on the CD. Internet connectivity is only required for accessing hyperlinks to the web such as Project 2061 tools. The dynamic format allows users to have access to supplementary hyperlinks on the CD that support the teaching of the unit such as samples of student work. The curriculum product also contains many additional resources produced by the District to support the unit.

Units contain the following components (as applicable):

(1) Unit Overview document
(2) Unit Benchmarks document
(3) Student Misconceptions document
(4) Unit Blueprint
(5) All student lab sheets, worksheets, and assessments created by District 27 to supplement publishers' materials
(6) Samples of student work
(7) Video clips of lessons/set-up of experiments
(8) Hyperlinks to supplementary resources
(9) Slideshows of lab directions
(10) Pacing guide for each lesson/unit
(11) Teacher tips in addition to ones provided in publishers' teacher guides
(12) Pictures of experiments and set-ups

The Home Page (Figure 1) provides hyperlinks to Project 2061 online resources and hyperlinks to grade level units.

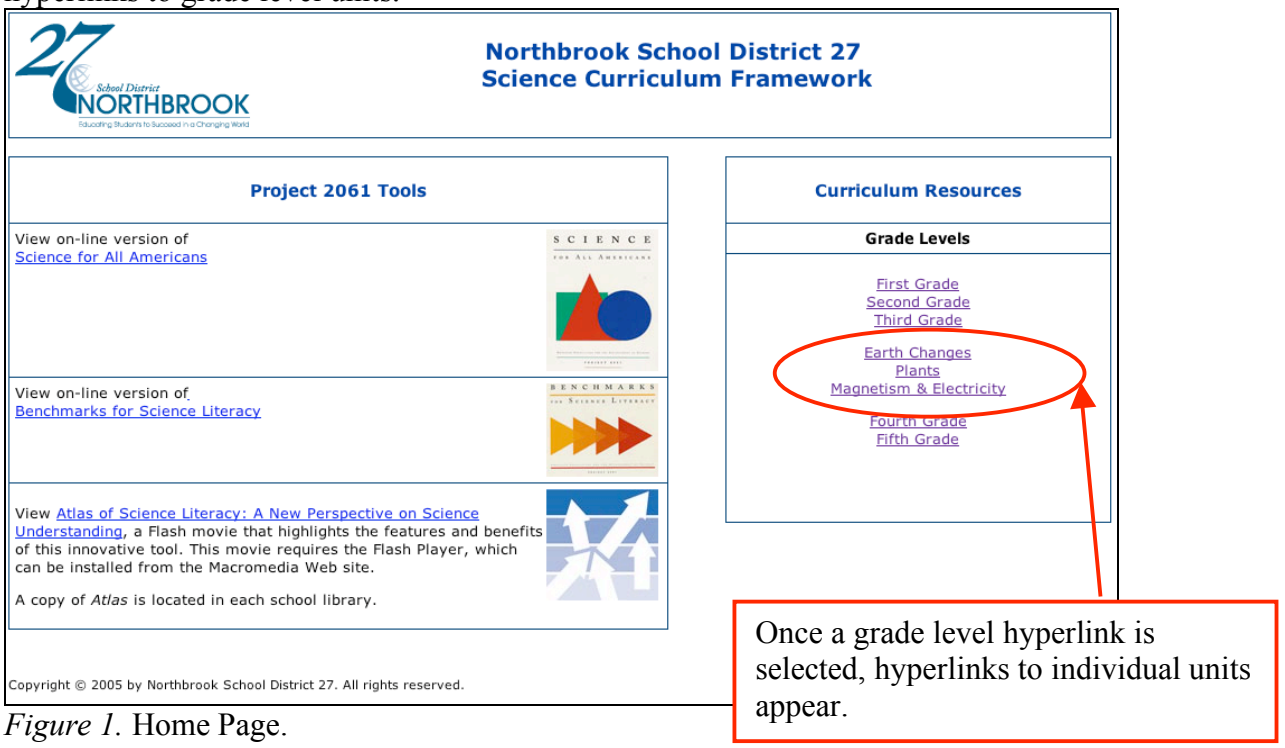


Figure 1. Home Page.

Each unit has a standard Unit Home Page (Figure 2).

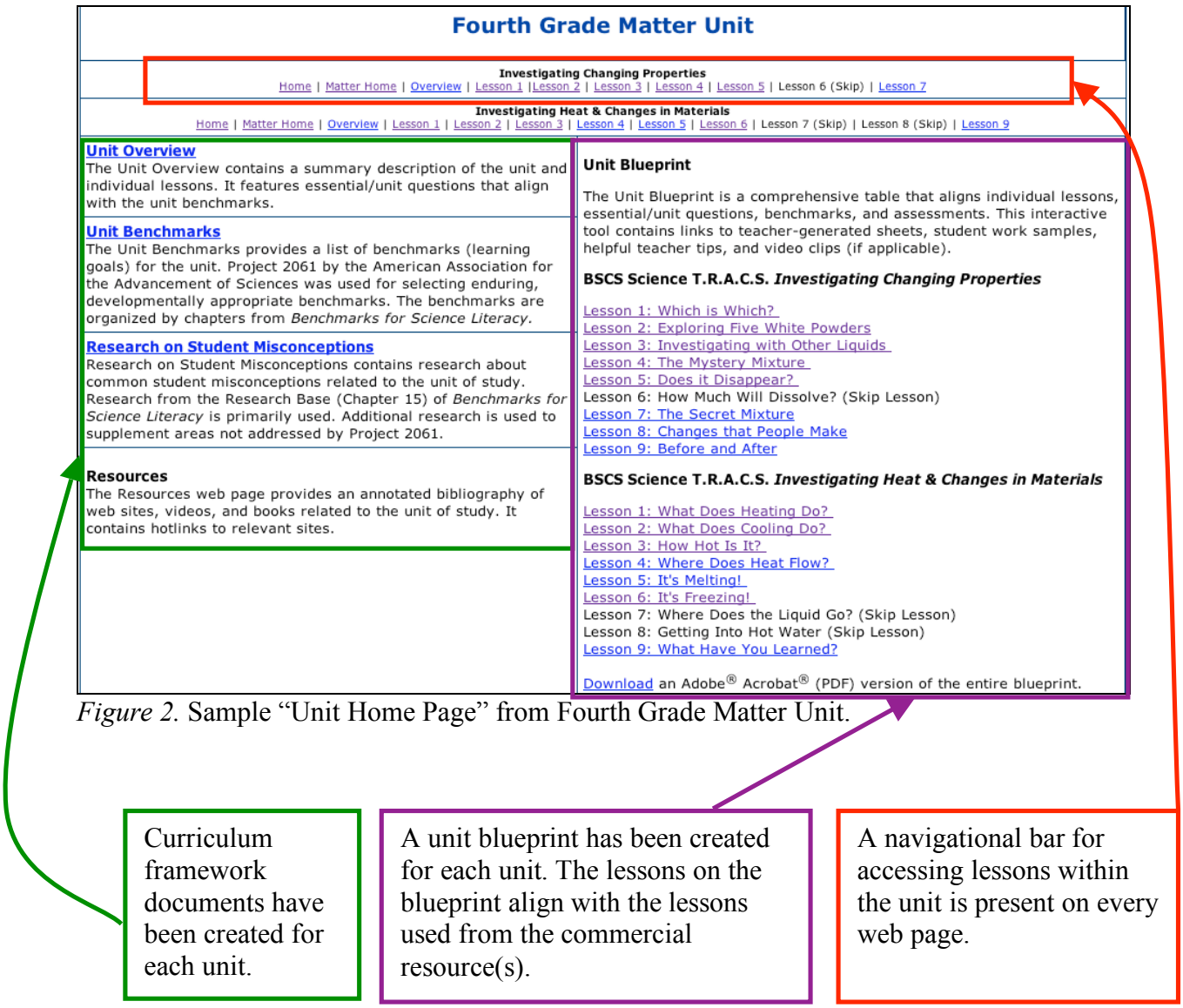


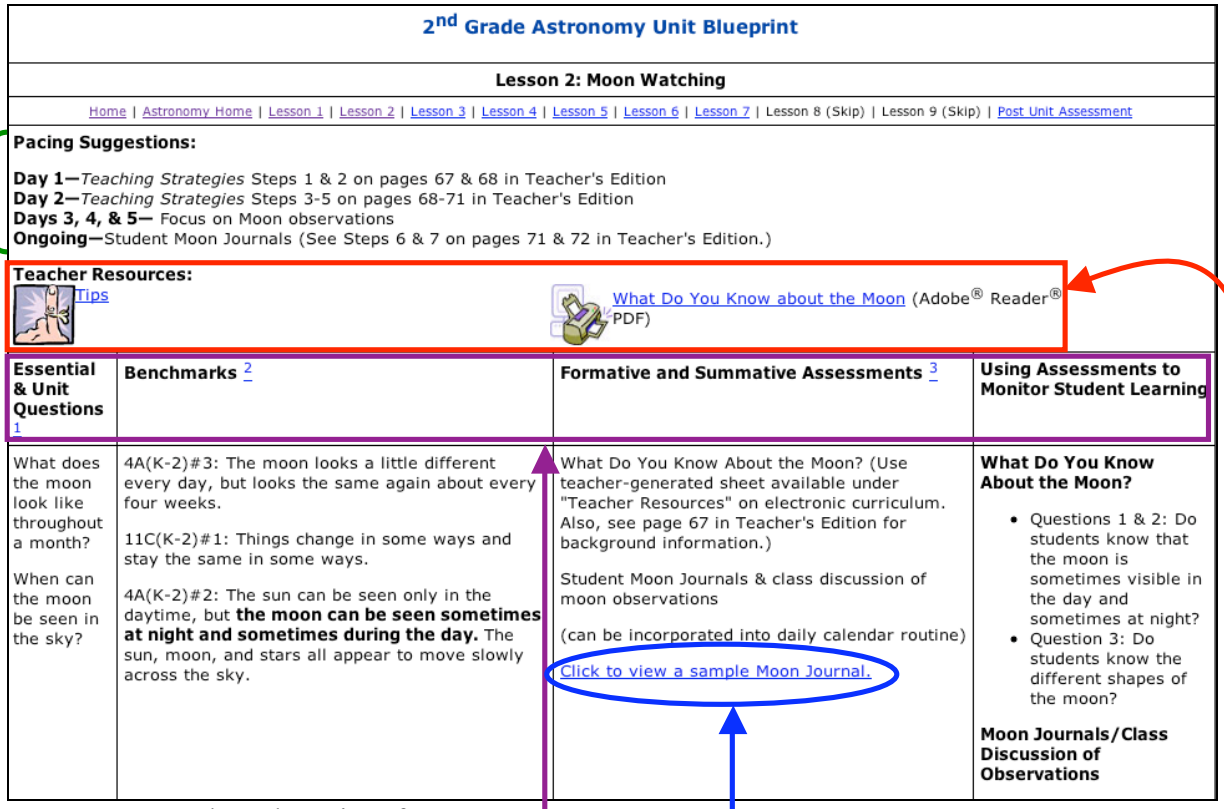
Figure 2. Sample "Unit Home Page" from Fourth Grade Matter Unit.

Curriculum framework documents have been created for each unit.

A unit blueprint has been created for each unit. The lessons on the blueprint align with the lessons used from the commercial resource(s).

A navigational bar for accessing lessons within the unit is present on every web page.

Figure 3 illustrates a sample blueprint in electronic form. Teachers may work off the electronic blueprint, which is highly recommended, or they may download a printable version of the blueprint for the entire unit. By using the electronic blueprint, teachers have immediate access to all the support resources that are hyperlinked to the blueprint.



2nd Grade Astronomy Unit Blueprint

Lesson 2: Moon Watching

Home | Astronomy Home | Lesson 1 | Lesson 2 | Lesson 3 | Lesson 4 | Lesson 5 | Lesson 6 | Lesson 7 | Lesson 8 (Skip) | Lesson 9 (Skip) | Post Unit Assessment

Pacing Suggestions:

Day 1—*Teaching Strategies* Steps 1 & 2 on pages 67 & 68 in Teacher's Edition
Day 2—*Teaching Strategies* Steps 3-5 on pages 68-71 in Teacher's Edition
Days 3, 4, & 5— Focus on Moon observations
Ongoing—Student Moon Journals (See Steps 6 & 7 on pages 71 & 72 in Teacher's Edition.)

Teacher Resources:

Tips

What Do You Know about the Moon (Adobe® Reader® PDF)

Essential & Unit Questions 1	Benchmarks 2	Formative and Summative Assessments 3	Using Assessments to Monitor Student Learning
What does the moon look like throughout a month? When can the moon be seen in the sky?	4A(K-2)#3: The moon looks a little different every day, but looks the same again about every four weeks. 11C(K-2)#1: Things change in some ways and stay the same in some ways. 4A(K-2)#2: The sun can be seen only in the daytime, but **the moon can be seen sometimes at night and sometimes during the day.** The sun, moon, and stars all appear to move slowly across the sky.	What Do You Know About the Moon? (Use teacher-generated sheet available under "Teacher Resources" on electronic curriculum. Also, see page 67 in Teacher's Edition for background information.) Student Moon Journals & class discussion of moon observations (can be incorporated into daily calendar routine) Click to view a sample Moon Journal.	**What Do You Know About the Moon?** • Questions 1 & 2: Do students know that the moon is sometimes visible in the day and sometimes at night? • Question 3: Do students know the different shapes of the moon? **Moon Journals/Class Discussion of Observations**

Figure 3. Sample "Blueprint" from Second Grade Astronomy Unit

A pacing guide has been created for each lesson. It specifies sections from lessons that should be taught.

Essential questions, benchmarks, and assessments are aligned throughout every lesson. Assessments are formative and summative. Informal means of gathering information about student learning such as class discussions are also considered assessments.

Student work samples have been included in many units. The samples contain informational notes for teachers.

Supplementary teacher resources beyond the commercial product have been created to support the implementation of the curriculum. Supplementary resources include teacher tips, lab directions for students, pictures, video clips, lab sheets, and formal assessment documents.

"Teacher Tips" are designed to supplement information provided in the publishers' teachers' guides. The "tips" also include information about changes made to the kit or lessons.

Helpful Teacher Tips

Lesson 2

Experiment Supplies (See *Before You Begin* on page 59 in Teacher's Guide)**:**

- Make sure to collect shoeboxes with detachable lids prior to starting the unit. Approximately 8 are required.
- Play sand has been added to the kits.

Safety & Goggles: Students must wear goggles during the *Sand Blasters* experiment. Goggles have been added to the kit. At the end of the unit, the goggles, along with the kit, will be collected. At that time, the goggles will be sterilized.

Running the Experiment: Per the directions in the Student Guide (see page 32), students are to blow through the straw for one minute. Thirty seconds is sufficient for attaining the desired results.

PowerPoint slides containing abbreviated lab directions are available on the electronic curriculum. The slides can be displayed on classroom TV monitors.

For teachers' reference, pictures of the three index cards from the *Sand Blasters* experiment are available on the electronic curriculum.

Student Observations/Drawings: During the first set of experiments, the students blow the pile of sand gently and harder. Bullet #6 on page 32 in the Student Guide instructs students to draw pictures. Making accurate pictures is one of the unit benchmarks. To make this experience the most meaningful, student should draw the sand three times: (1) prior to blowing gently, (2) after blowing gently, and (3) after blowing harder. A top-down or bird's eye view works best when drawing the boxes with the sand piles. While it is tempting to make a sample drawing for the students and tell them how to do it before conducting the experiment, the learning experience is much more meaningful if students are allowed to approach the drawings their own way and then reflect upon them.

Suggestions for Facilitating Student Reflection on Drawings: A very effective method for facilitating this type of reflection is to use a variation of the Jigsaw method. For example, if the lab groups were comprised of three students, form three large reflection groups. Each student in a lab group should be assigned to a different reflection group. Students should share and explain their drawings. Each student should think about something they learned and something they would change in their own drawings as a result of sharing. The students can then be brought back together for a whole class discussion.

***Nature's Sand Blaster* Reading (pages 35-36 in Student Guide):**

- Students should not be held responsible for knowing the two bolded words within the reading (eolian and ventifact).
- The last bullet on page 65 in the Teacher's Guide is extremely important.

Figure 4. Sample "Teacher Tips" document from 3rd Grade Earth's Changes Unit.

Conclusion & Contact Information

Northbrook School District 27 is firmly committed to increasing science literacy and achievement in all students. The District's electronic curriculum product serves as a model of a rigorous and coherent curriculum. Its dynamic format supports on-going refinement and continual learning by teachers and students.

Districts interested in the electronic curriculum product should contact the Assistant Superintendent for Curriculum, Instruction and Assessment at:

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847-498-2610
www.nb27.org

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