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Classroom Field Test of Scott Foresman's Intermediate Science *Earth in Space* Unit

Spring 2004

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Executive Summary

Introduction

This past spring, Empirical Education Inc. conducted a classroom field test of a new version of Scott Foresman (SF) Science. The pilot materials targeted the elementary intermediate grades (5^{th} and 6^{th} grade), and featured a number of new Scott Foresman elements including scaffolded inquiry, hands-on investigations, and the integration of reading. The pilot unit was on *Space and Technology*, with a focus on *Earth in Space* (Unit D, Chapter 16). Materials consisted of a Student Book, a Teacher's Edition, and accompanying kit materials for the unit's lab inquiry activities.

Teachers from two different school districts -- Charleston, West Virginia (WV) and Philadelphia, Pennsylvania (PA) -- participated in the classroom pilot test. These two districts were selected after having been identified by Scott Foresman as districts currently using either Harcourt Brace materials (WV), or FOSS materials (PA.)

Evaluation Goals

The primary objectives of the field test were to investigate teachers' reactions to, and classroom implementation of, the new features of the product, within the broader context of science instruction in their schools and districts. Findings from the field test provide a preview of teacher reactions from future users of the new materials, and point to a set of design recommendations to be considered for future versions of the science curriculum.

Sample and Classroom Pilot Implementation

A total of seven teachers participated in the field test -- four 5^{th} grade teachers from Charleston, and three 6^{th} grade teachers from Philadelphia -- and were drawn from a total of six public elementary schools. The Charleston teachers were identified through a Scott Foresman sales representative based in Charleston. The Philadelphia teachers were identified through the district's science specialist, who felt that the space unit fit more closely with the sixth grade curriculum than the fifth grade curriculum.

All four Charleston teachers were current users of the Harcourt Science textbook. The three Philadelphia teachers' use of science materials was much more varied, and unlike what was anticipated, none of the teachers was a user of FOSS. Two of the Philadelphia teachers were users of the Holt, Rinehart and Winston's "Science Plus" series. The third teacher had no current science textbook, but was a former user of the Harcourt text.

The field tests occurred over a twelve-week period in Spring 2004. For the actual classroom implementation, teachers, on average, devoted a total of eleven class sessions, across a four-week period

A variety of research methods were utilized for the field test. Methods included an initial teacher survey, teachers' initial review of pilot materials, a teacher use activity log, classroom observations, a teacher mid-point interview, a teacher post-program interview, and a review of student work and teacher-created materials.

Key Findings

Formative evaluation results indicate that teachers were very positive about various aspects of the new SF Science materials. They also recommended several areas of improvements.

Appeal of materials to students and teachers: Teachers noted students' positive reactions to the materials, saying that the students found the space topic and materials interesting, the illustrations, photographs, and colorful graphics appealing, and the hands-on activities engaging.

Good readability and accessibility of materials. Teachers were uniformly positive about how easy the materials were for students to read, and appreciated its visual aspects such as the visual dictionary of key vocabulary.

Teacher –friendly materials . Teachers found the Teacher's Guide very useful, and easy-to-follow. They felt it offered a lot of different options for activities and teaching techniques, yet in a format and layout that was easily accessible and flexible.

Integration of reading and science valued. Teachers were enthusiastic about the ways in which the pilot materials integrated reading and science, citing the importance of such an approach given district priorities in literacy and reading across the curriculum.

Interest in more opportunities for student writing. Teachers were generally positive about the various writing assignments in the student book and teacher's guide. Several voiced that there should be more opportunities for writing. All seven teachers created their own additional writing assignments to incorporate in their teaching of the pilot materials.

Scientific inquiry progression generally well-received: Teachers were generally positive about the progression of laboratory inquiries (going from directed, guided, to full) and the ways in which the materials addressed the 5 E's (engage, explore, explain, evaluate, and extend.) Teachers did express that, at times, the materials needed more depth and that labs needed a closer relationship to the scientific method, and data collection and analysis.

Well matched to standards, assessments and teacher needs: Teachers felt that the materials filled a need they had for themselves and their students, adequately prepared students for meeting their districts' science standards and standardized tests, and would be acceptable to teachers in their district as a core science program.

Desire for greater depth of materials and instructional approach: While teachers and students found the student book easily accessible and readable, a number expressed interest in materials that offered more scientific depth and detail for this age group. Similarly, teachers liked the scaffolded questions and lesson check points, but some found the questions more focused on recall and straight comprehension, rather than deeper or more inferential reasoning or extensions of scientific concepts or phenomena.

Need for more student demonstrations and activities of scientific concepts: Given the inherently physical and spatial nature of the earth in space unit, several teachers supplemented the pilot materials with additional activities involving the students' actions and movements to model the sun, earth, moon and planets. They found such activities critical in helping students better understand the complex notions of rotation vs. revolution, orbits, and how the earth's seasons and day/night relate to its orbit around the sun.

Interest in deeper and more diverse range of assessment questions for "check points", scaffolded questions, and final chapter assessments. A number of teachers felt they needed more and "deeper" lesson check point questions, scaffolded questions, and end-of-unit questions so that they were more than short recall or straight comprehension questions. Types of assessment questions that teachers brought in from supplemental materials included essay questions, and more complex multiple choice questions.

Value of materials addressing of teachers' time constraints: Teachers liked the clear layout and modular, flexible approach to the teachers' guide, given the time constraints they felt when teaching science in their classrooms. However, several pointed out that time assessments underestimated the actual class time involved.

Appreciation of inter-disciplinary connections. Teachers liked the ways in which the materials included activities involving mathematics and social studies. Teachers also appreciated the technology links, and opportunities for students to use the Internet to further their scientific learning.

Design Recommendations

Preserve the highly readable, engaging visual format of the student materials. Students and teachers alike responded positively to the easy readability, interesting content, and attractive nature of student materials.

Maintain the user-friendly format of the teacher guide, its plentiful offerings of helpful classroom activities and its valuable utilization of literacy-related skills in the learning of science. But, be realistic in the time likely to be required by activities, to ensure that most teachers can carry out "quick activities" in 15-minutes or less.

Maintain the integration of reading and science instruction. Teachers greatly valued and appreciated the consistent use of literacy strategies and approaches in the science text and science instruction. Look for regular opportunities to suggest use of common graphic organizers, such as K-W-L charts, and other tables and visual tools.

Increase the depth of information in scientific materials. While preserving the appropriate readability of materials, concisely provide more scientific detail and depth on key topics for the intermediate grades. This will be addressed to some degree in the future *leveled readers*, which were not available for the pilot testing.

Keep the "scaffolded inquiry" and progression of directed, guided, and full inquiry. Teachers very much liked the progression of inquiry types, and the use of the 5 E's. Consider providing some more depth and interesting variability in collected data for the directed and guided inquiry, so that investigation results are not always easily predictable, nor produce an identical set of results across all students.

Increase the number of student demonstrations, hands-on activities and investigations of scientific concepts featured in a unit. Teachers highly value students' hands-on investigations, at a somewhat higher priority level than straight teacher demonstrations and reading from science texts. Activities should include both labs and investigations, and active student hands-on activities and modeling of principles.

Strengthen connections between lab activities and the scientific method, data collection and analysis. Include opportunities to integrate mathematics and more quantitative data and analysis in lab experiments.

Incorporate greater opportunities for student writing, to enhance students' scientific learning and strengthen literacy skills. .

Increase, deepen and broaden the types of science assessment used for "check points," scaffolded questions, and final chapter assessments. Assessment questions should not disproportionately emphasize straight recall questions, but include more open-ended writing responses, more multi-dimensional multiple choice options, and questions with multiple solutions.

Continue to allow for the use of technology, and for offering curriculum connections to social studies and mathematics. Teachers greatly valued and appreciated ways in which the science text promoted students' technology use and allowed them to access greater information resources via the Internet. Cross-disciplinary links to other subjects provided interesting learning opportunities and applications of knowledge, and allowed teachers to utilize materials in more than "science-designated" time slots

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I. Introduction

This past spring, Empirical Education Inc. conducted a classroom field test of a new version of Scott Foresman (SF) Science. The pilot materials targeted the elementary intermediate grades (5^{th} and 6^{th} grade), and featured a number of new Scott Foresman elements including scaffolded inquiry, hands-on investigations, and the integration of reading. The pilot unit was on *Space and Technology*, with a focus on *Earth in Space* (Unit D, Chapter 16). Materials consisted of a Student Book, a Teacher's Edition, and accompanying kit materials for the unit's lab inquiry activities.

Teachers from two different school districts -- Charleston, West Virginia (WV) and Philadelphia, Pennsylvania (PA) -- participated in the classroom pilot test. These two districts were selected after having been identified by Scott Foresman as districts currently using either Harcourt Brace materials (WV), or FOSS materials (PA.)

The primary objectives of the field test were to investigate teachers' reactions to, and classroom implementation of, the new features of the product, within the broader context of science instruction in their schools and districts. Findings from the field test are designed to help Scott Foresman anticipate potential reactions from future teacher users of the new materials, to understand promising implementation methods for the new materials, and to offer design recommendations for future versions of the science curriculum,

Sample

A total of seven teachers (five women and two men) participated in the field test: four 5^{th} grade teachers from Charleston, and three 6^{th} grade teachers from Philadelphia. The teachers were drawn from a total of six public elementary schools. Initially only six teachers were selected for the pilot test, but a seventh teacher, who team-taught with one of the Charleston teachers, enthusiastically volunteered to be part of the field test, and was integrally involved in all aspects of the field test. The Charleston teachers were identified through a Scott Foresman sale representative based in Charleston. The Philadelphia teachers were identified through the district science coordinator, who felt that the space unit fit more closely with the sixth grade curriculum, rather than the fifth grade curriculum.

All four of the WV teachers were current users of the Harcourt Science textbook. The Philadelphia teachers' use of materials was much more varied, and unlike what had been anticipated, none was a user of FOSS. Two of the Philadelphia teachers were users of Holt, Rinehart and Winston's "Science Plus" series. The third teacher had no current textbook, due to her school's budget. (The school had this year expanded from a K-5 to a K-6 school, so this sixth grade teacher did not have any regular science materials in her classroom, and instead relied on the Internet and newspapers as sources for written science materials this year.) She was a former user of the Harcourt text.

The majority of the teachers were highly experienced, with five of the seven teachers (all 4 WV teachers, and 1 PA teacher) having at least 20 years of teaching experience. Two of the Philadelphia teachers were new to the teaching field, with one to three years of teaching experience. Teachers reported teaching elementary science each year of their teaching career. Six of the seven teachers were "regular" classroom teachers, and responsible for teaching all core subjects to their students. The remaining teacher was the science specialist in her Philadelphia school.

Most (5) of the teachers indicated that they had taken one to three science workshops or courses the past three years,, while three teachers indicated that they've taught over 20 workshops the past three years. All of the teachers had previously taught a solar system unit to upper elementary school students (grades 4^{th}, 5^{th} and/or 6^{th}), while two teachers indicated that they also had taught the solar system to high school students.

Regarding class size, six of the seven teachers had class sizes of between 19 and 25 students. The science specialist, who worked in a school with a high proportion of visually impaired students, taught a total of 45 students, but in groups of 15 students at a time, once a week.

When asked what proportion of students in their class they would describe as having high level of interest in science (e.g., scientifically curious, eager to do activities, interested in asking questions), all four of the WV teachers described "all/almost all" of their students as highly interested in science. The Philadelphia teachers offered somewhat more conservative estimates, with two indicating 1/2 their class, and one indicating 3/4's of the class, as having high scientific interest.

Procedure

Both districts were involved in a spring field test of the materials. Initial teacher meetings were scheduled as early in the spring as possible, following recruitment negotiations to identify interested teacher participants, and production and shipments of SF pilot materials to field sites. The initial teacher meeting with Charleston teachers was in late March, while the initial teacher meeting in Philadelphia was in mid-April. Teachers were encouraged to start using the pilot materials shortly after the initial meeting, once they had time to sufficiently review the materials and plan their implementation.

The West Virginia teachers were given the general time frame of using the materials from late March through the end of April (6 week period, including one week of this was devoted to spring standardized testing). The Philadelphia teachers were given the general time frame of using the materials from mid-April through the end of May (6 week period,). Teachers were told to use the materials as they saw fit, and could "pick and choose" activities, and use them in a different order if they wished. Teachers were also told that they could adapt the materials if they felt it would better serve their students, as well as could supplement the pilot materials with other materials if they felt it would better help their students learn about the solar system.

A variety of research methods were utilized for the field test. Methods included an initial teacher survey, teachers' initial review of pilot materials, a teacher use activity log, classroom observations, a teacher mid-point interview, a teacher post-program interview, and a review of student work and teacher-created materials. All interviews were conducted individually.

The initial teacher survey and teachers' initial review of pilot materials were conducted during the teacher "kick-off" meeting at the beginning of the pilot test. The primary focus of the initial teacher survey was to obtain background information on the teachers concerning their current approaches, attitudes, and classroom practices surrounding science instruction, and their assessment of their current science text. A brief discussion of these issues was held following teachers' completion of their surveys. The second part of the meeting was devoted to teachers' initial review of SF pilot materials. Teachers first reviewed the student edition, and recorded perceived strengths and weaknesses on a response form, and then followed a similar procedure when reviewing the teacher's edition. A brief discussion of teachers' reactions to each booklet followed. The meeting concluded with the evaluator explaining the guidelines and requested time frame for the pilot test.

The classroom observations and teacher mid-point interview were conducted roughly three weeks after the beginning of the field test. Each teacher was observed for a single class session, that lasted approximately 45 minutes to an hour. Close-to-verbatim notes of the classroom sessions were recorded by hand for the session by the evaluator. Following each observation, the evaluator interviewed each teacher for roughly 45 minutes, to learn about the teacher's reactions and reflections upon the lesson they had just taught, and reactions to the SF plot activities and lessons they had done to date.

Throughout the field test, teachers kept an activity log of pilot materials, and collected samples of student work and additional materials that that teachers created, or used, in conjunction with this solar system unit. These logs and classroom materials were submitted to the evaluation team prior to the conduct of the final teacher interview.

The final teacher interviews were conducted shortly after each teacher completed using the pilot unit, and were typically one hour in length. During the interview, both teacher and evaluator freely referred to the actual student and teacher editions, the activity logs, and any additional materials teachers had used with their students. Both mid-point and final interviews were audiotaped and later transcribed for analysis.

The primary research focus of both the field test instruments and subsequent data analysis was an investigation of teachers' responses to the SF Science materials, with a particular emphasis on its new core features of scaffolded inquiry, hands-on investigations, and the integration of reading.

II. Teacher Profiles

Primary goals of science teaching

During the initial teacher meeting, teachers were asked what they saw as the most important thing they wished students to get from science in their classrooms. Teachers most commonly mentioned three different themes: 1) instilling a love or interest in science; 2) becoming aware of science in the world around them, and 3) experiencing hands-on experiments and process skills and inquiry, with four of the seven teachers making such points. As one teacher expressed: "The most important thing for students are to become aware of the world around them, develop a love of science, and know how to investigate, set-up an experiment and collect data." Only two teachers specifically mentioned knowledge of science curriculum areas or science content per se as a teaching goal.

Teachers conveyed a similar set of educational values for science learning when asked to rate the importance of various teaching approaches to science, on a ten-point scale (1 = "not at all important" to 10 = "extremely important.") As shown in Table 1, teachers strongly voiced the great importance of students seeing a connection between science and the real world, and students assuming an active role in posing scientific questions, collecting and analyzing data, discussing and interpreting results from investigations, and conducting hands-on investigations. Teachers were also positive about connections between science and other curriculum areas, use of hands-on science models and students designing their own investigations, and students writing about science. The teaching techniques that were rated lowest in importance were more teacher-directed and less active techniques utilizing textbooks, such as teacher-led demonstrations, teacher-led discussions of materials read in textbooks, and class time spent reading science content in textbooks.

Table 1: Importance of various teaching approaches to teaching of science

(10 point rating scale; 1 = not at all important; 10 = extremely important)

How important is it to have:	"5"	"6"	"7"	"8"	"9"	"10"	Range	Avg. Rating
Connection between science and the real world						(7)	All 10s	10
Students posing scientific questions					(1)	(6)	9 - 10	9.86
Collecting & analyzing data					(1)	(6)	9 - 10	9.86
Students discussing and interpreting results from investigations					(2)	(5)	9 - 10	9.71
Connections between science and other curriculum areas					(2)	(5)	9 - 10	9.71
Hands on investigations				(1)	(1)	(5)	8 - 10	9.57
Use of hands-on models of scientific concepts and principles			(1)	(1)		(5)	7 - 10	9.29
Students designing their own investigations			(1)		(2)	(4)	7 -10	9.29

Students writing about science				(2)	(2)	(3)	8 - 10	9.14
Students doing independent research involving written sources (library, internet)		(1)			(4)	(2)	6 - 10	8.86
Use of authentic scientific phenomena, objects and situations			(2)	(1)		(4)	7 - 10	8.86
Students making science presentations			(1)	(2)	(2)	(2)	7 - 10	8.71
Teacher-led demonstrations	(1)		(1)	(1)		(4)	5 - 10	8.57
Teacher-led discussion of materials read in textbook	(1)			(2)	(1)	(3)	5 - 10	8.57
Class time spent reading science content in textbook	(1)		(4)		(1)	(1)	5 - 10	7.43

(n = 7)

Biggest challenges as science teachers

Teachers reported that their biggest challenge as a science teacher was time, with four of the seven teachers mentioning that they did not have as much time as they would like to devote to hands-on inquiry approaches to science (e.g., "My biggest challenge is minutes in a day to set up the investigative/explorative aspects of the lessons, and also the time for students to adequately explore"). The next commonly expressed challenge concerned materials, and the supplies, equipment and space needed for hands-on investigations (3 out of 7 teachers.) As one teacher expressed, "There is not enough time in the schedule or enough space…Science takes planning, clean up, and it takes many hours." One teacher also mentioned a challenge being "keeping current, "up to date" on new discoveries."

Time devoted to teaching core subjects

The teachers reported devoting less time to teaching science each week compared with reading/language arts and mathematics, which they taught daily. Teachers ranged in teaching science from two times a week to five times a week, on an average of a little over 45 minutes per class session (Table 2). On average, teachers reported spending comparable amounts of time on science and on social studies.

Table 2: Amount of time each week devoted to teaching in core subject areas

Subject	Ave. # of days per wk	Avg. # of mins. per day
Reading/Language arts	5 days/week (daily) (Range = All 5's)	88 minutes (Range: 50-120 mins)
Math	5 days/week (daily) (Range = All 5's)	67 minutes (Range: 45 –90 mins.)
Science	4 days/week (Range = 2–5)	47 minutes (Range: 40 – 53 min.)
Social Studies	4 days/week (Range = 2-5)	50 minutes (Range: 40-70 mins.)

Hands-on investigations and textbooks; connection between science and literacy

The majority of the teachers (6 out of 7) said that they had students involved in hands-on investigations quite regularly, at least every 3-5 class sessions. Textbook use was a bit more varied across the teachers, with teachers about evenly divided about whether they used their textbooks almost all sessions, every 3-5 sessions, or every 6-8 sessions

Table 3: Frequency of using hands-on investigations vs. textbooks

	All/almost all sessions	Every 3-5 sessions	Every 6-8 sessions	Every 9-12 sessions	"Other"
"How regularly do you have students involved in hands-on investigations in your science class?"	1	4	1	0	1 "every 2-3 sessions"
"In the past four weeks, how often did you use your textbook materials?	3	2	2	0	

When asked why they thought hands-on investigations were important in their science classes, several teachers mentioned that "children develop a deeper understanding with hands-on experiences," and "hands-on activities make the words in a book make more sense." Another added that "many kids don't like to read through textbooks."

One teacher also emphasized the importance of selecting worthwhile, thoughtful hands-on experiences, since "it's a challenge to stop science projects from being used as just an art project. Science needs to be as respected as reading."

Teachers believed that it was important to use science as an opportunity to address reading and writing, yet felt that they were only moderately successful at doing so, at present. (Tables 4a and 4b).

Tables 4a and 4b: Importance and satisfaction ratings of using science to address literacy skills

How important is it to:	**"5"**	**"6"**	**"7"**	**"8"**	**"9"**	**"10"**	**Range**	**Avg.**
Use science as an opportunity to address reading, writing and other literacy skills for students?		(1)		(1)		(5)	6-10	9.14

(10 point rating scale; 1 = not at all important; 10 = extremely important)

How successful do you feel you've been	**"5"**	**"6"**	**"7"**	**"8"**	**"9"**	**"10"**	**Range**	**Avg.**
Using science as an opportunity to address reading, writing and other literacy skills for students?		(2)	(2)	(1)	(1)	(1)	6-10	7.57

(10 point rating scale; 1 = not at all successful; 10 = extremely successful)

As one teacher expressed, “At the elementary level, students are initially interested in science but then they are beaten down by reading. We have to foster excitement; keep the fear [of science] from developing.”

The West Virginia teachers indicated that there was a West Virginia law that required at least 50% hands-on activities in science, and described themselves spending at least close to half their time on hands-on activities. They also stated that there was a state-wide mandate to use writing in every subject.

Influence of standardized testing

In Charleston, WV, the teachers reported that standardized testing in science began in the third grade, and that students were tested in science in the third, fourth, and fifth grades. The Philadelphia teachers reported that standardized testing began in their school at the first or second grade.

Teachers felt that their science instruction was moderately influenced by what is tested in standardized tests.

Table 5: Influence of standardized testing on science instruction

	“5”	“6”	“7”	“8”	“9”	“10”	Range	Avg.
To what extent do you see your science instruction being influenced by what is tested in standardized tests.	(1)	(2)		(3)		(1)	5-10	7.29

(10 point rating scale; 1 = not at all influenced; 10 = extremely influenced)

The West Virginia teachers also described the ways in which the standardized tests are prioritizing what content and topics are covered in the curriculum.

III. Initial Critique of Current and Pilot Textbooks

Teacher views on current textbook

As mentioned above, all four WV teachers were current users of Harcourt Brace science texts, while one Philadelphia was a former user of Harcourt. When asked to describe the Harcourt textbook features they liked best, each of the teachers mentioned a different feature. Responses included: the science investigations, the subject and resources, the usable layout of materials, the teacher-friendly guide, and the illustrations/diagrams that made things clear to students. Teachers also described liking the science kits and the videos, and the fact that the curriculum is correlated with STAT9 test. Teachers were more similar in their descriptions of what textbook features they liked least, with three of the four teachers mentioning that the chapters were too detailed, the length of the chapters were too long, and that the terminology (i.e., readability) was too hard for many students. Teachers also commented on the sizeable "heft" and weight of the materials, and not liking the tests featured in the textbook.

For the two Philadelphia teachers who primarily used the Holt Reinhart and Winston text, teachers mentioned liking the content and teacher resources. Features they disliked varied. One teacher felt that the text did not have enough content information, its pictures did not pertain to content, and that the inquiry lesson involved materials that are not teacher friendly and difficult to obtain or maintain (e.g., earthworms, acid.) The second teacher mentioned that the pictures needed to be multicultural, and that the fonts could be larger, given her visually impaired students.

Initial review of SF pilot materials

The second half of the initial teacher meeting was devoted to teachers quickly reviewing the SF pilot materials, and to learn of their initial impressions. Teachers were first asked to review the student edition, and write what they regarded as its most important strengths and weaknesses. The teachers were then asked to review the teacher edition, and write down the strengths and weaknesses of those materials. Following their written reviews, the teachers then discussed their reactions as a group with the evaluator.

Review of SF student edition:

Teachers were highly positive in their initial review of the SF pilot materials. First and foremost, the teachers commented on the *good graphics and illustrations* of the student materials, with all seven teachers commenting on this feature.

Four teachers noted the *good readability* of the text, its use of *graphic organizers*, and its *connection to math and other subjects.* Three teachers noted the *lesson checkpoints*, and the incorporation of *writing*.

Regarding the *lab activities*, two teachers noted how the materials for experiments can be produced by teachers, while two others either mentioned liking the "lab zone" or that the directed inquiry lessons seemed interesting.

The *test prep*, the *take home activity*, the inclusion of *technology*, and the *Build Background* section were each noted by two teachers. A variety of other features (e.g., objectives, take home activity, career section, highlight of key concepts) were noted by only one individual.

In their group discussion of the materials, teachers mentioned liking the easy flow of the materials, and the good visual illustrations.

As one teacher expressed, "I like the reading skills. The pages are not so cluttered – everything is focused. Ranger Rick is [too] busy – something in this corner, something there, etc. This type of format is easier for ADA/ADHD kids…The visuals are good because they assume that the kids can read the lab and do it, but also the guided inquiry shows what is needed, even for an inclusion student."

Regarding problems with the materials, teachers identified few weaknesses upon this quick, initial review. Three of the four WV teachers noted the potential time to set up experiments. The Philadelphia teachers focused more on problems with the breadth or depth of the materials:

> *Very broad lesson. Lesson 1 contains 9 planets plus different characteristics to explain solar system.*
>
> *Science process skills.*
>
> *Do you access existing knowledge? Questions could be more challenging. Making just inferences? Hypotheses could be used more.*

In their review of the two-page spreads devoted to the two lab activities during the group discussion, teachers mentioned liking the clear step-by-step instructions, the fact they already have many of the materials, and that the experiment involves students making inferences and followed the 5 E's. One teacher asserted that the amount of time indicated for the moon box activity (30 minutes) underestimated the time likely to be involved.

Review of SF teacher edition

Teachers were also very positive in their initial impressions of the Teacher Edition. When asked to note its most important strengths, a number of teachers focused on special assessment and student learning features, with five teachers noting the *Diagnostic check* feature, and four noting the *Science Misconception* feature.

Three teachers noted the *concept mapping and graphic organizers*, the inclusion of *technology* and internet sites, and the provision of the *toll-free number*.

Two teachers noted the *differentiated instruction*, the *leveled readers*, the *quick teaching plan*, and the *professional development* feature.

Regarding the hands-on investigations, two teachers said they liked the clear list of materials needed for each inquiry activity, and while one mentioned the step-by-step instructions provided. One teacher indicated that she particularly liked the "think about it questions", the essential question, and the fact that the types of inquiry (directed, guided) were broken down for teachers.

Teachers' views on the weaknesses of the Teachers' Edition were somewhat similar to their reactions to the Student Edition. Two teachers noted the time element, while one expressed a concern about not getting all the materials needed. One teacher noted that a good deal of other resources (e.g., internet, books, library) were needed to cover the topics addressed, while another noted a possible editing error in the materials (the term "Essential Question" should be used instead of the term "Build Background" as the key question on page 514.)

IV. Classroom Implementation of Pilot Materials

As noted earlier, teachers in both districts were given a six-week time frame in which to use the pilot materials. Teachers were encouraged to use the materials as they saw fit, and could adapt or supplement the materials if they felt it would better help their students learn about the solar system.

For the actual classroom implementation, teachers chose to devote a total of eleven class sessions, on average, to using the SF pilot materials (range 5-16 sessions). On average, they used the materials across a four-week period (range 3 - 7 weeks).

When asked how much of the student pilot materials they used, six of the seven teachers reported that they used "a lot" (i.e., three quarters of the materials or more), while one teacher reported using "some" (between a half and three quarters of the materials.) One of the six teachers who reported using "a lot", in fact only used the materials with her students for a total of five class sessions. (This teacher was a science specialist who met only weekly with her class, and the five class sessions were the maximum amount of time she felt she could spend on it, before the school year ended.) Presumably, her "a lot" assessment pertained to how much of those particular lessons she used (i.e., how many features and sub-activities), as opposed to the proportion of the total student book that she used (which were roughly All seven teachers reported using "a lot" of the Teacher's Edition.

All seven teachers reported adapting the materials "relatively little." Regarding their use of additional materials to supplement the SF unit, four of the teachers reported "relatively little" use of additional materials, while three teachers reported using "some" (1) or "a lot (2) of additional materials. A description of these supplemental materials, and reasons teachers felt they were needed, are provided in a later section.

Overall Impressions and Evaluation

During their final individual interviews, teachers were very positive in their reactions to the SF pilot materials. When asked to rate them on a scale of 1-10 (1 = "didn't like it at all;" 10 = "I really liked it"), all the teachers rated the student materials between "8" and "10", with an average rating of 9.14. Teachers also rated highly the ways in which the curriculum materials filled a need they had for themselves and their students, with an average rating of 9.14 (range 7-10). All seven teachers believed that this kind of material adequately prepared students for meeting their districts' science standards and for doing well on their standardized tests.

Teachers also rated highly the materials' ease of use (average rating = 9.43; range 8-10), and its appeal for students (average rating = 9.14; range 7-10) and for teachers (average rating = 9.0; range 7-10). Teachers were slightly more varied in opinion about the overall educational value (average rating = 9.0; range 6-10).

When describing what they liked most about the materials, teachers talked about the materials' appeal for students They also felt that the materials were easily readable and comprehensible to students. As two teachers described:

They loved everything about the book. The biggest benefit was that the students were really excited and they enjoyed science. It's not boring or dry.

> It was comfortable material for the students. This is a make it or break it age for the children, and this motivates them.

Several teachers also described that they liked the layout of the materials, and found them to be "very organized and very teacher friendly, and not overpowering", and "flexible so teachers could adapt it to what they wanted to do." Several teachers also mentioned that they liked the visual illustrations, photographs and graphics in the materials. Teachers regarded the primary benefits of the materials being that it allowed students to learn the basic concepts, and that it included inter-disciplinary connections with mathematics and reading.

Teachers felt the unit mapped well onto what the curriculum they needed to cover, given their districts' standards and assessments. Teachers cited the unit's coverage of the phases of the moon, revolution, rotation, location and size of the planets, and dealt with earth, motion, and the solar system.

Regarding what they did not like about the materials, several teachers felt that there needed to be more hands-on activities ("each lesson should have a hands-on activity"), and that there needed to be more depth of information (e.g., "the introduction to the planets is too brief.")

Several teachers also felt that the "time limits were off", saying that the hands-on activities took much longer than indicated in the book. One teacher felt that "the quick activities and diagnostic checks were too long – and could be complete lessons by themselves."

Teachers were also asked how acceptable they felt this program would be to teachers in their district as a core science program. All seven teachers felt that the materials would be acceptable to their colleagues, citing its easy readability, teacher-friendly materials, and that not overwhelming. As several teachers remarked:

> It would be very accepted. Even teachers who are not familiar with science can understand this. It would make teachers more confident with science. It's less stress for a teacher because it's easier to understand for everyone.

Our lead teacher saw the book and loved it. He wanted to use it. For the teachers who are reluctant to do experiments, these are easy to do. Sometimes the materials [other texts ask for] can be crazy to use, like chemicals. I think everyone would like it.

I think a lot of the teachers would like it. I showed this to the other teachers and they thought it was user friendly.

It would be acceptable if they had the training. It's good that it's a small book. It's not an overwhelming textbook.

Three teachers made explicit comparisons with their current Harcourt Brace text, and voiced preference for the piloted SF materials.

I was used to the wordy and loaded down science series that we were using, but the kids just love this (the SF pilot materials.) I felt like I needed to add to it, but I didn't have to.

I compared this (SF) to Harcourt Brace and the Harcourt turns the teachers off. It (Harcourt) is more of a reference book.

It's written so that kids can read it. The students struggle with the current book.

Regarding what kinds of teachers might find the materials more useful, versus less useful, teachers offered a variety of views. On the positive side, one teacher mentioned that for teachers who have trouble teaching science because of time, this book was easy to use and offered straightforward activities. Another felt that the interdisciplinary connections would speak well to those teachers who don't feel they have enough time to do science. "If a teacher wants to, they can pull in reading, math, and social studies." A third teacher believed that the book offered lots of options for more experienced teachers, "because they would find more ways to use it, such as for ELL students. It's more adept with diverse and/or differentiated learning."

Several teachers felt that the materials, while less wordy than their current text, might have some teachers "feel like they wanted more meat." One also said that the materials "are more useful for teachers not confident about science; less for those who want lots of experiments." Conversely, one teacher said that "for those teachers who only read to their class, they wouldn't like it."

Teachers did not believe there were many major barriers to using the materials. A few mentioned challenges such as "not enough time to cover the material" and "once materials get used up, the district does not have money to replace it (e.g., clay)." The science specialist also pointed out problems with lack of training and professional development.

Scientific Content and Inquiry

Teachers were asked what they thought about the kinds and amount of scientific content covered in this Earth in Space chapter. Regarding the breadth and depth of materials, five believed that the materials had enough breadth, while two offered a more measured view: "They gave the basics, which is good in a time crunch" and "It was fine for topics that they did target. However, there should be more detail and more descriptions." Concerning depth, only three of the teachers felt that the materials had enough depth, and four felt that the materials needed more information and more detail.

There should be more information on the planets. For the Seasons, there should be more content. I had to supplement this lesson with a demonstration. The students really had difficulty with this concept.

The book doesn't provide enough detail; it's too general For example, they don't mention the concept of a leap year or statistics on the planets. It's more of a basic reader…The introduction to the planets is too brief. The kids were hoping that they (SF) would get more into the planets. Hopefully, the other chapters will cover more… Also, the book is not up to date. SF says 23 people have walked on the moon and I think there have been more.

It should be more in-depth. The basic information is good for the primary grades. This is more for a 4th grade level. The biggest lesson was on the Moon and it needs more detail.

Traditional science books have too much detail and this book doesn't have enough. The students want more…It should be more in-depth. I want a little more reading text. If children are above reading level, this falls short.

It would be good to have a list of fascinating facts for teachers to share with students.

Informal discussions with students in four of the classrooms we observed also revealed that a number of students felt the materials were too easy, and could use more and harder content.

It seems too easy; some of the stuff people already know.

I liked it, but there should be more paragraphs. They should add more information. It needs more information as to why the earth is tilted.

They should put small boxes with interesting facts: Did You Know?

The book is not hard enough; some things are from the third grade. I want to know more.

Six of the seven teachers used a number of the different hands-on activities featured in the pilot materials. (The remaining teacher was a science specialist who met only once a week with each class of students, and only utilized the non-activity lessons.) Of the six teachers who used hands-on activities, all six used the clay/ruler and moon box activities, three (one individual teacher, and one team of two) used the payload rocket activity, and one team of two teachers did one of the science fair activities.

The six teachers who used the various investigative activities in the pilot unit were asked to respond to specific aspects of this set of hands-on activities. First, they were asked what they thought of the intended progression of the science labs, from the directed (clay/ruler activity) to guided (moon box) to the full inquiry experiment of the Wrap Up of unit D (the rocket launcher experiment, and science fair options.) Four of the six teachers (all from WV) felt that it was a good progression, while the two Philadelphia teachers did not regard the clay/ruler activity as truly an inquiry:

There wasn't a whole of predictions (with the clay and ruler activity). There was only one question – which ball hit the ground first and why. This was more of an observation.

The moon box was more of an experiment than the clay and ruler. The ruler could be used more as part of an anticipatory set

Classroom observations of students using this ruler/ball inquiry in one of the classrooms found that while students had fun doing the activity, they largely anticipated what the results were going to be. As two students commented:

The experiment was too easy. We knew what was going to happen.

It was fun, but we already knew what it's going to be.

Five of the six teachers felt that the activities were sufficiently rich and open-ended, and that the activities adequately allowed students to deal with prediction, data collection and analysis, and interpretations of results. Five of the six teachers also felt that the activities sufficiently addressed the 5 E's (engage, explore, explain, evaluate and extend), while one felt that the activities were stronger at "engaging and exploring", but not necessarily the last three E's.

Of note, four of the teachers created written activities to accompany the two lab activities, as well as adapted the labs in other ways. These efforts appeared both to bolster the investigative nature of the activity, and to make the connection between the activity and the real space phenomenon more explicit. For example, one teacher created a lab report sheet for each student to fill out in conjunction with the blay ball/ruler lab, by making "a recording sheet set up using scientific method format." The cover page said, "Does Distance Matter?" (the question offered as the heading in the Explore in the SE.) The inside pages and back cover then featured a number of questions for students to respond to:

Question: Does a planet's distance from the Sun matter?

Hypothesis/Prediction:

Materials: Clay, meterstick, ruler

Procedure: 1. Make two clay balls the size of golf balls.
2. Push one ball onto the end of the meterstick. Push the other ball onto the end of the ruler.
Note: The clay balls represent the planets. The other end of the rule and meterstick represent the Sun because the planets orbit the Sun.

3. **Hold up the meterstick and the rule. Place the empty end of each against the floor.**
4. **Let go both at the same time. Observe closely.**

Conclusions: Which ball hit the ground first?

Explanation: Why did the ball on the meterstick take longer to hit the ground?

Scientific Explanation: How do you think a planet's distance from the Sun affects the time needed to make one orbit?

Extend: Predict what would happen if you included a clay ball on a 6" rule and a clay ball on a broom handle in the experiment?

(Note: New sentences added by the teacher are featured in bold. Some sentences are drawn from the student page or TE's 5 E's, but now appear as part of the students' recording sheets.)

Other teachers modified the activity to increase its investigative nature by asking students to make and record a prediction before they conducted the "ruler drop", or asking them to conduct three trials of the ruler drop, and record each finding in a table.

One teacher indicated that "the students didn't understand that it was an experiment. They didn't get the concept about distance until I did the demonstration." For this demonstration, the teacher had three students come up and pretend that they were the Sun and two planets. He then had the two "planet students" walk around the "sun student", while touching their ruler or meter stick to the "sun." In this way, the students could visually see how the rule or meter length corresponded to distance between the sun and planets, and was used to determine the size and distance of the orbit. This same teacher recommended that the clay and ruler activity should be close to the solar System pages (SE pp. 520-521), rather than appear four pages earlier (SE p. 516).

Several teachers mentioned that the unit was lacking supporting materials and worksheets, and felt that it was important to include supporting worksheets. One teacher, whose classroom we had observed doing the "ball/ruler" inquiry, mentioned in her mid-point interview that in hindsight, she wished she had prepared a worksheet to accompany the lab.

> "[If I were to do it again], I would have a worksheet ready. I like the Science Journal [that I have them keep] but sometimes they need a worksheet. They need the questions that I'm asking them right in front of them. If I take the time to write the questions on the board then they are going to be lost. I even tried to photocopy this (TE – pp 516, with the miniature worksheet drawing) and enlarge it, but it didn't work…
>
> > *The book asks two questions, and they're good questions, but the first one is a very simple question: Which ball will hit the ground first? That will take a minute to answer whereas the other question ("Infer: How do you think a planet's distance from the Sun affects the time needed to make one orbit?") is a little more in-depth. I wish there were a few more questions and I wish I had made up a few more questions for them myself. They get off-task very easily, so they work well when you give them 3-5 questions.*

In another classroom in which we observed this ball/ruler activity, students recorded three trials of the "ruler drop", and shared these findings with the whole group. However, when discussing which ball dropped first and why, one student said that he thought it was due to the meter stick's greater weight, not its length (or the resulting distance of the arc.) Thus, there may need to be more "intermediate" questions between ones that ask for straight recall or observation, and the more difficult inferential questions.

Our observations and the teacher interviews also found the activity to have some procedural difficulties, such as the importance of having a single student release both the ruler and meter stick simultaneously, rather than to coordinate two different students trying to release the sticks at the same time. A number of teachers also mentioned getting the color of the colored modeling clay all over their hands. One of the teachers took about an hour ahead of time to prepare all the clay balls, and stick them on the sticks

Four teachers felt that the two activities specifically designed for Chapter 16 (the clay ball/rule and the moon box) offered a satisfactory number of activities for the chapter and an appropriate ratio of hands-on activities to reading science materials, while two expressed the need for more hands-on activities in the chapter. One WV teacher stated that WV expects 50% of a science curriculum to feature hands-on activities, and "there should be one activity every lesson. That's what West Virginia will expect. The current book (Harcourt) has an activity after every lesson."

Overall pacing, variety and flow of science activities

Our classroom observations indicated that most of the teachers utilized a thoughtful and varied flow of activities across a class lesson, and drawing upon a logical sequence of different activities from the SF materials. All but one teacher began the day's science lesson with a review of previously introduced concepts and information with the whole class, with reviews lasting anywhere between five to 15 minutes. This whole group activity was then followed by some sort of individual or small group activity (lasting between 10-15 minutes), in which students either engaged in a lab activity (such as the clay ball/ruler activity, or the "top spinner" activity) or a writing activity. The teachers then brought the class back together for a whole class activity for about 10 minutes, such as reading a 2-page spread from the student book, or student demonstration activity, or a discussion of findings from the lab the students just completed. This whole group activity was then followed by a second individual or small group activity (writing or hands-on) before the class wrapped up.

The five teachers observed engaging their class in such an alternating pattern of whole group/small group activity also had fairly "interactive" methods for students reading the SF student materials. Approaches were quite varied, and ranged from a teacher reading the materials outloud and frequently stopping to explain and discuss points, to having students read independently while teachers talked with individual students, or had students record information on their own. (Teachers' different methods for handling students reading of materials will be described in more detail in a later section addressing literacy and science.)

The main exception to this interactive, alternating instructional format was a teacher who followed a highly structured routine of having students read aloud from the textbook, with each student taking turns to read two sentences aloud at a time, before stopping to allow the next student to read. While students began the class session in an animated fashion, and were eager to ask lots of questions that reflected a genuine interest they had about space, the questions came across as "off-topic" and were answered by the teacher in only a cursory fashion, since the main objective of the class appeared to be the students' reading of four pages of the text (SE pp. 522-525), which was written on the blackboard at the outset of the class. There were no opportunities to discuss the text, nor to have any extended conversation about any of the questions students voiced at the beginning of the sessions (e.g., "Why does air stay here?" "What makes gravity?" "If we could go to Pluto, would we weigh more?") Following their reading aloud of the text, the teacher then read aloud five questions from the text (2 Lesson Checkpoint questions, and three questions from the TE's Scaffolded Questions.), which students then answered in writing, and later check against the teacher's correct answers.

The distinctly different teaching approaches that we observed appear consistent to the teachers' more general instructional styles, as evidenced by the teachers' daily activity logs, and their descriptions of lessons as conveyed during their teacher mid-point and final interviews.

Teacher reactions to individual science activities

In general, all of the different pilot activities received high ratings in the teachers' daily logs, in which they rated each day's activities for its appeal to students, and its educational values. The vast majority of activities received both the highest appeal rating of the three point scale ("Great" vs. "Good to OK" and "Fair to Poor") and the highest educational value rating of the three point scale ("high value " vs. "moderate" and "low" value) from all or most of the teachers. The few exceptions were as follows.

One team of teachers felt that the *top activity* (Quick Activity: Activate Prior Knowledge, TE p. 522) was low in appeal, and low in educational value. They felt that the tops were difficult to make and use, and took a long time to do. Another teacher thought it looked somewhat interesting, but decided not to use it because he viewed getting the lids together as a "long term" effort. In contrast, one teacher thought the activity was "simple but very effective. The students got the concept."

The teacher team also felt that the *pattern of seasons portfolio* (TE p. 525) was moderate in educational value, and was an "OK activity." While they generally liked it, they thought it would take too much class time and assigned it as a homework activity. Another teacher felt that the portfolio was too simple, and chose not to use it. In contrast, another teacher rated this activity as high in appeal and high in educational value, saying that "incorporating art and science really got the kids interested and excited about science."

The guided inquiry *moon box activity* (SE pp. 530-531) while valued by teachers, took much longer than the book indicated. One teacher said that while the book said it would take 20 minutes, it actually took her two days to complete the activity. This teacher remarked, "Some of the inquiries, i.e., the moon, were more complicated than the book seemed to make it out to be." Another teacher said that he spent over an hour doing "prep work – taping the flashlights and putting the holes in the boxes," and still "it took forever for the kids to cover the box in black. The overall activity took over an hour."

Most teachers cited problems with suspending the ping pong ball in the box, saying that either it wouldn't stay affixed (one teacher used tape rather than the thumbtack), while several said that the ping pong ball kept swinging on its thread which made observations extremely difficult (one team suspended the ball using a straightened paper clip to stop the swinging, and found that worked much better.) One teacher cited that since the ball was opaque, it was difficult to see the shadows on the ball, as intended, and for the students to see the simulated moon phases. Once the activity was assembled, however, several teachers mentioned how much the students enjoyed the project. "The kids were so excited. Even after the 45-minute lesson, the kids still wanted to look at the boxes."

The three teachers (one individual teacher, and one team of two) who used the Full Inquiry *Payload Rocket* activity (excerpted from the Wrap Up for Unit D) were positive about the activity. "It really demonstrated the effects of payload. It was great; the paperclips really worked well." The only complaint concerned that "the holes in the plastic bag kept getting too big", so one teacher put duct tape on the end of the baggie, and then put a hole through it. A fourth teacher who did not have time to use the Payload Rocket activity, expressed the clear appeal it have for students. "One boy was so disappointed that we didn't do the rocket experiment that I wrote out the directions for him to do at home."

Difficult science concepts and need for student demonstrations and activities

Most of the teachers commented on the difficulty of some of the science concepts featured in the unit, and the importance not only of good illustrations and text, but the need for additional student demonstrations and activities. This seemed particularly important given the inherently physical and spatial nature of many of the unit's key scientific concepts (e.g., rotation, revolution, orbit, and the movement of the earth, moon and planets, in relationship to the sun), coupled with the near impossibility of watching the actual scientific phenomena take place (short of time-lapse video photography from space.)

> *The concept of the near side of the moon and the far side of the moon – my students had difficulty comprehending this concept.*
>
> *Students had a very difficult time grasping the concept that the moon rotates at the same rate it revolves. Teachers need a list of activities to get this idea across.*
>
> *For the seasons, there should be more content. I had to supplement this lesson with a demonstration. The students really had difficulty with this concept.*

Several teachers mentioned that the students had particular difficulty with one illustration (SE p. 525), which attempted to explain the seasons.

> *Yesterday we went into the seasons. They got the tilt, but you know something that was confusing, for some reasons the students had trouble with this drawing. They just couldn't visualize it; even some of the better students had trouble. When were showing, on June 21st, and we talked about if the North Pole was slanted towards the sun, that's when you have your summer. But they said, "look where we are – here in the dark. For some reason, that little yellow dot confused them.*

Four of the teachers utilized a number of additional student demonstrations and activities to model some of the different scientific concepts. One teacher, who frequently supplemented the pilot materials with additional activities and materials, engaged her students in at least four such student activities. In "All in One Year', students place brightly colored post-it note on a globe to mark their state's location, and held the earth at about a 23 degree tilt. One student stands at the center of the class holding a lit flashlight to represent the sun, while another child walks in a counterclockwise orbit around the sun, turning the globe in a counterclockwise direction as he walks (to represent the passing of days.) The "Sun" is instructed to shine its light on the globe as the earth student circles her, and it is pointed out that it takes 365 days (one year) to complete this orbit.

In another activity, students played a version of "Simon Says" called "Sun Says" where each child is asked to walk around his/her desk when asked to "Revolve", vs. turn in place when asked to "Rotate." Students in this classroom also engaged in a number of other demonstration activities throughout the pilot test, including role playing activities to convey the moon's motion and why we only see one side of the moon, and the moon's phases.

It should be noted that the TE did feature three places where students do a "role playing" activity. In one (TE p. 518) students simply stand in a row to show the order of the planets in descending size (from largest to biggest), and in another (TE p. 526), two students stand apart holding a basketball and a tennis ball to estimate the scaled distance between the earth and the moon (with these objects, the scale would be about 24 feet). A third activity is featured as an example of a demonstration under a Science Misconception (TE p.515), concerning revolution vs. rotation. In this example, however, the teacher directions seem to emphasize the child's moving in an elliptical path around the sun to show a revolution, versus a student turning in a circle as he moves around the Sun to show a rotation. A possible advantage of the "Sun Says" activity is that it simply isolates and contrasts rotation vs. revolution. This can then by followed up with an activity such as "All in One Year", which combines the earth's revolution around the sun with rotation, with the post-it note and flashlight making clearer the ways in which rotation contributes to day and night.

Science assessments

Teachers were generally positive about the materials' features addressing assessment (lesson checkpoints, Chapter 16 Review and Test Prep.) There were two main concerns that were raised. First, teachers felt they needed more and "deeper" lesson check point questions and scaffolded questions so that they were more than recall questions. It should also be noted that the sample answers were often single verbatim phrases from the text.

In one classroom, we observed how a teacher had students record the scaffolded questions and then were asked to write down the answers. As a whole group, the teacher then read each question aloud and proceeded to announce the book's answer, after which he called upon individual students to read aloud what they had written, to see if students had gotten the answer correct. Thus, rather than have the students first offer their answers and hold a possible discussion to arrive at a correct idea, it resembled more of a "here's the correct answer. What did you get?" interaction. Furthermore, students at times expressed a number of incorrect responses and misconceptions, but the teacher did not use this as an opportunity to discuss their ideas, nor correct their misconceptions. Thus, teachers may need greater assistance and support in the teachers' guide and training to grasp that there is a possible range of ways students might express a correct idea, and to learn how to guide a discussion to better understand students' current conceptions and misconceptions, and to lead them to a clearer understanding of the concept at hand.

Second, teachers noted some problems with the Chapter 16 review, noting that there were inconsistencies in terms and content (i.e., terms and ideas in the test did not match those given earlier in the text content). For example, one test item focused on "inner and outer planets", although those terms were not used in the materials students read, while another question dealt with "light and temperature patterns", whereas earlier the students mainly were presented content on day/night and seasons. Similarly, there is no discussion of "layer of gases" featured in Test Problem #4. Teachers also noted that some test items, such as those in the Process Skills, were significantly harder than others. Also, teachers felt that a "model building" task involving materials, such as for Problem #13, was difficult logistically.

A few teachers created their own assessments, or used ones from other curricula. One teacher primarily adapted the Chapter 16 test, including adding some clearly-worded essay questions focusing on key concepts (e.g., "What causes day and night?" "Why does Earth have seasons?")

This teacher also recommended the need for more worksheets, and for there to be an evaluation of some kind after every few lessons, rather than only at the end of the chapter.

Another teacher used a "Sun-Earth Survey" from the GEMS unit (The Real Reasons for Season). The three items featured were quite different in format than those offered in the SF materials, and are worth noting. Two items were multiple choice, but featured visual, diagrammatic choices, in keeping with the ideas being tested. One item asked "Which of the four drawings do you think best shows the shape of Earth's orbit around the Sun? (The view is top down.) The four choices showed: two circular orbits (Choice A: one in which the sun was in the center, and Choice B: one in which the sun was towards the left center of the "circle"), and two elliptical orbits (Choice C: one in which the sun was in the center of the ellipse, and Choice D: one in which the sun was towards the left center of the ellipse.) Thus, this visual multiple choice item focused on students' understanding not only of the elliptical vs. circular orbit, but of the relative placement of the sun within that orbit.

The second item focused on both the size and distance of the Earth and Sun, but also included information about the moon as well. The question asked *"Which is the best drawing to show the sizes and distances between the Earth and the Sun?"*

Choice A: Picture showing the Earth as a 1/4" circle, the moon as an 1/8" circle two inches away from the Earth, and the Sun as a 1/2" circle 6 inches away from the Earth.
Choice B: Picture showing the Earth as a 1/8" circle, the moon as an 1/8" circle one inch away from the Earth, and the Sun as a 1/2" circle 6.5 inches away from the Earth.

Choice C: Picture shows the Earth as a "pin-head size" circle, the moon as an even smaller dot 3/4" away from the Earth, and a circular outline of the sun at the right hand margin of the page, with a label "Sun is about 11 page widths away."

The third item, presented only in text, poses students a question with possible multiple solutions, and plausible information included in options.

"Why do you think it is hotter in the United States in June than in December? Circle all that are correct.

A. Because the Sun itself gives off more heat and light energy in June and less in December.
B. Because the Earth is closer to the Sun in June, and farther away from the Sun in December.
C. Because the United States is closer to the Sun in June, and farther from the Sun in December.
D. Because the United States is facing more toward the Sun in June and away from the Sun in December.
E. Because the Sun gets higher in the sky in June, so its rays are more concentrated on the ground.
F. Because the Moon blocks out the Sun more in December.
G. Because in the United States, there are more hours of daylight in June than in December.

Thus, the GEMS test, while short and clearly structured with multiple choice options, offered more substantive questions and responses than the SF's more vocabulary-oriented comprehension questions, and at the same time, in a more straightforward structured manner than SF's open-ended "Explain Concepts" and "Process Skills" text items. The GEM items, through their use of visuals, also more clearly targeted the visual and spatial nature of the key concepts in the Earth and Space unit. It seems worthwhile to have the SF tests include more visual, as well as more complex multiple choice/structured test items in their worksheets and end-of-chapter and end-of-unit tests.

Integration of Science with Reading and Writing

Instructional methods of engaging students with textbook materials

Collectively, the field test teachers displayed a diverse range of instructional methods of having students engage in the written pilot textbook materials, as evidenced by our classroom observations and teacher interviews. Of the four West Virginia 5th grade teachers, one teacher read the textbook pages aloud as students silently read along, and stopped frequently to discuss, explain, or ask questions about the text students were reading. The team of two teachers engaged their students in what they called "guided reading" – having students read pages silently to themselves, as the teachers circulated around the room, and asked questions of students to "make sure they were understanding." The fourth West Virginia teacher adopted a highly structured "traditional" approach of reading instruction, and had students take turns reading aloud to the whole class, in which a student would read two sentences aloud to the class, before stopping and having another student resuming reading his/her two sentences, etc. Discussion of the text was limited largely to a short question and answer format at the end of the reading passage, with the teacher's questions primarily drawn verbatim from the teachers' guide.

The two Philadelphia teachers adopted more independent reading approaches with their classes, as well as more closely integrated writing into the process. One teacher had the students break into small guided reading groups, in which each group could decide whether they wished to read silently, have one person read out loud, or take turns reading out loud. After reading two pages, the group was asked to come up with five questions, and "the groups switched off developing the questions and then answered them." The second teacher gave students a structured chart of the planets to fill out, and asked them to read the pages on the planets and to take down notes of information they had read.

Readability of text

Regarding the readability of the written text, six of the seven teachers felt that the readability level was 'just right". Teacher comments included:

> It was appropriate. It was challenging for some, and easy for others.
>
> > *My class ranged from a 3rd grade reading level to an 8th grade. I had a lot more students reading, even those that have never read out loud before.*
> >
> > *I have IEP students and they didn't struggle with the reading.*

The teacher who read the text aloud to the students indicated, "It is much easier to read than the current book. I might consider letting the kids read it [by themselves.]"

One of the sixth grade teachers felt it was "too easy," saying "My students range from 4th to a 7th grade reading level. The vocabulary words are too simple. They already know what most of the words mean. It talks about the atmosphere but doesn't say what it's made of."

In informal discussions with students held during the classroom visit to four of the classrooms, students expressed to the evaluator varying opinions regarding readability. As with the teachers, students in each of the classes varied as to whether they felt the text was "just right" or "too easy", with respect to both readability and content. Several also made some suggestions as to additional features (e.g., a glossary, word lists of important terms) they would like.

Table 6: Students' Views on the Pilot Materials' Readability

Appropriate Level	Too Easy
I can understand it better; it's explained better.	*It needs longer paragraphs with more facts.*
It was easy, the other book was too hard.	*It's easier to understand than our other book (the Harcourt text), but I was bored with a few of the lessons. The moon was interesting, but it could have been harder.*
It's easy to read. The words are small.	*I would like a list up front of important words. [Also]on the tilt, there was only one paragraph.*
I like to read it; it's interesting.	*There should be more words highlighted.*
I like the definitions and pictures	*Our old book explained the words. It had a dictionary in the back. This one should have dictionary.*

The integration of reading with science

Teachers were asked what they thought about the unit's design which intended to integrate reading instruction with the science materials, and whether they found the approach worthwhile and effective. All seven teachers were positive about this approach. One teacher expressed how important it was, given district initiatives and pressure to focus on reading and mathematics, to the exclusion of science.

> It fits right in with our district, which requires reading in science and math. Right now, there is a movement in our district to delay science until middle school and focus on reading and math. It didn't pass, but it's out there.

Most of the teachers specifically mentioned liking and using the KWL Chart:

> *I used the KWL Chart. The "What I want to Know" - most of what students wanted to know was covered in the book.*
>
> *I like the KWL chart and the Graphic organizer. They set things up well for the students.*
>
> *The KWL chart was great. They realized they know more than they expected….I didn't think they would know a lot about certain things but especially when it came to satellites, they mentioned cell phones and radio signals. They were telling me a lot more than I thought they knew… They can use this (KWL chart) in other subjects as well.*
>
> *I like the fact that they did the KWL and then reviewed the concepts as well as showed the pictures of the vocab words. I had the kids draw the axis, elliptical and rotation, and revolution.*

Individual teachers remarked liking different aspects of the materials, such as the extended vocabulary, the bold highlighted vocabulary terms, and the visual preview of key terms, and the scaffolded questions.

Individual teachers also recommended that certain features be improved such as better and more check point questions, and the need for more reading materials.

> *I didn't like the checkpoint questions. They were too broad. There should be more questions. A Checkpoint Question should dissect the material and these didn't.*
>
> *The recall questions were too easy. They don't make them think.*
>
> *I wished that they had added more Checkpoint questions. I would put the Scaffolded questions in the student book [rather than just have them in the TE.]*

They need to add more reading. There might be more useful information in the worksheets.

Five of the seven teachers indicated that they felt that the inclusion of reading instruction techniques enhanced their effectiveness of teaching science to students.

> *It gives them information that they didn't know. Example: In the extend for axis and rotation, we discussed the many uses for satellites.*
>
> *To infer, predict, and model – we use these things in other subjects. I'm going to use this format in my reading class.*
>
> *It enhanced my effectiveness. It helped the students understand what they were reading.*
>
> *I liked that the strategies are the same as are used in English class.*

One teacher felt that the reading instruction techniques did not detract from her science practice but simply did not make too much of a difference, indicating that if she didn't like the particular the prompts or questions, she simply added her own questions.

Writing

Teachers were asked what they thought of the various writing assignments featured in the student edition or suggested in the Teacher's Edition. All seven teachers were generally positive, although several voiced that there should be more writing. All seven of the teachers created their own additional writing assignments that they used in conjunction with the pilot materials. Several teachers had students keep science journals, in which students wrote a variety of things concerning the materials they had read, and activities or labs they performed:

> *With the Clay Ball, I had the students write down the 5 E's. With the shoebox, I had the students complete the chart.*
>
> *[For the labs, my students wrote] predictions, inference, observations, and conclusions.*

With each experiment, I had the students write their prediction, hypothesis, summary, results, and write a paragraph on them.

> *We did a science journal. They wrote about what they observed, what they learned, and if they had any questions. [For the "observe the moon" activity], they had to write an explanation to 5 year olds explaining the phases of the moon.*
>
> *My students kept a journal and wrote about the KWL, facts and inferences, and writing about recall.*

One teacher also incorporated a number of additional creative writing assignments into this solar system unit. For example, the teacher had an assignment titled "Far Out Chores", in which students fill out a 3-columned chart of different chores and first describes how that chore is done on earth, and then to briefly describe how they think that chore is done on the International Space Station. Once they have completed the chart, they "can find out the truth by reading all about it", in a written passage that the teacher then gives students. Chores featured common "kid-like" chores, such as "make bed," "take out trash," "set table," "make dinner," and "wash dishes."

This same teacher also included two interesting creative writing assignments: a "Postcards from Space" research assignment (that augments the descriptive writing assignment about being on the moon featured on SE p. 535), and a "The Right Stuff" personal essay on what it means to be an astronaut. Both assignments are featured below.

Postcards From Space

Directions: Imagine you're on vacation in space (for instance, soaking up solar rays on Venus, roping a rocky ride on an asteroid, or spelunking on a cavernous moon). Research the location and imagine what it would be like to vacation there. Write a postcard to a friend expressing your feelings and insights about your vacation. Please add a stamp and a postmark for an authentic look. Then flip over the postcard and add an illustration of your intergalactic destination.

The Right Stuff

What does it mean to have the "right stuff" to be an astronaut? You are to write one or two paragraphs about one or more of the questions below.

- Would I make a good astronaut? Why or why not?
- What qualities do I possess that show I have the right stuff to become an astronaut?
- Is there a NASA career that appeals to me? Which one and why?
- What would I like to achieve if I became an astronaut?
- Is there another career for which I think I have the right stuff? What is it?

The teacher's writing handouts were nicely illustrated with appealing, colorful graphics and fonts, which made the writing assignments seem fun and inviting to students. The postcard assignment also featured as one of the illustrations an example of a postcard that the teacher had written, to provide a good written model of what she was encouraging in the assignment. This teacher also had another supplemental group writing and art activity, in which students worked in groups to create a "poster travel brochure" as a travel agency in charge of promoting its assigned planet.

In keeping with this focus on more open-ended creative writing, this teacher, and several others, also mentioned that they like the poetry assignment (TE p. 520) featured in the Teacher's Edition.

The team of two teachers also mentioned liking the descriptive writing in the unit. A third teacher also extended the materials into his students' spelling, and drew from terms in the pilot materials to be part of the students' spelling lists.

Cross-disciplinary connections

Math: A number of teachers commented on liking the incorporation of a mathematics activity in the pilot materials. One of the teachers extended the "dog weight" activity (SE p. 532-533) by having students figure out their own weights on the different planets. Another teacher indicated that her students did not find the "dog weight" activity very interesting until she sent them home with the homework assignment involving the food cans. " [Then] they really enjoyed the activity."

One teacher requested that the unit involve more math than it currently did. For example, he noted interesting math challenges concerning the conversion of years and days for planets (i.e., how some planet orbits are stated in terms of earth days, while others are stated in terms of earth years). This teacher also took the time to elaborate upon astronomical units during the class that we observed.

One of the teachers who incorporated a number of additional supplemental materials in her teaching of the solar system utilized three additional work sheets focusing on mathematics, produced by the Education Center, Inc. One sheet called "You Look Young for Your Age" had students figure out their age in years, for the nine planets (age in years x 365 days/number of days in one year on Mercury, etc.) A second sheet, "The Weight of the Worlds" had students complete a chart to figure out their weight on the different planets. The third sheet had two different parts. "Moon Math" featured a list of facts about the moon, in which a key mathematical figure was missing, and three multiple choice options were given. (e.g., "The moon is approximately____ miles from the earth." (2,400; 24,000; 240,000). After filling out the items, students are encouraged to check encyclopedias and other references to see if their answers make sense. Part II of the sheet was called "Fly Me to the Moon." Using a calculator, students are asked to figure out how long it would take them to walk to the moon, if they could walk to the moon. Students are given a chart with various methods of travel (e.g., walking, jogging, bicycle, automobile, passenger jet, Apollo space craft) and their respective speeds in mph, and are asked to figure out how many hours and days it would take to go to the moon via those different modes of travel.

It is worth noting that neither of the two hands-on investigations featured in Chapter 16 (the clayball/rule activity, and the moon box) featured any data collection, measurement or analysis that involved any mathematics. It was only with the third Payload Rocket lab in which mathematics was involved in terms of payload (number of paper clips) and measured distance.

Social Studies: Several teachers mentioned skipping the one featured social studies activity on the invention of time zones (SE 523) but mainly said it was due to time constraints, rather than lack of interest or appropriateness. A number of teachers described how they did like using the map for the "You are There" activity (SE p. 518) that illustrated how quickly one is rushing through space, given the earth's movement. One teacher commented that the "class was amazed by this quick activity – great way to hook the class." Another teacher indicated how hard it was for students to grasp the sense of distance, saying, "The students were confused about the 1,100 miles. They have no concept of how far that is. I was trying to figure out a way to explain it. I got the map and the yardstick out. Where else can you go in one second. We were doubling it, and add math into it, trying to determine how far you would go in 4 seconds…Even with this, they still didn't get it, and I thought they would. I think it might have even made them more confused. I think it's the students' background with looking at maps; they're not familiar with maps."

Another teacher showed the distance from Miami to Los Angeles with a piece of string, as instructed in the TE, and related it to something familiar to students – speed traveling in a car, and explained how many days at 70 mph it would take to get there by car. He then extended the use of the map and world geography by having students "take different starting points in the world and put the first part of the string on say, Iceland. The second part of the string, we asked where we could go in two minutes? We can go all the way to China. They were just mind boggled."

Technology: A number of teachers mentioned liking the opportunities to use technology in the unit. One teacher commented that she had tried to pull up one of the internet links listed in the pilot materials, but found that it wasn't active. Three of the teachers mentioned that they were having students use the Internet to obtain more information on the planets, with students in one classroom using Powerpoint to prepare a presentation. One teacher said he was drawing extensively from a site called "Starchild" for a number of supplemental activities and information.

A few of the teachers mentioned using videos in conjunction with the pilot materials. These videos included *Eyewitness Video: The Planets*, *Magic School Bus: Lost in Space* and *Read Science: Earth* by McGraw Hill.

V. Summary of Findings and Recommendations

Findings

In summary, the formative evaluation results of the Spring 2004 classroom pilot of the intermediate science Space unit indicate that teachers were very positive about various aspects of the new SF Science materials. They also recommended several areas of improvement.

Appeal of materials to students and teachers

Teachers noted students' positive reactions to the materials, saying that the students found the space topic and materials interesting, the illustrations, photographs, and colorful graphics appealing, and the hands-on activities engaging.

Good readability and accessibility of materials

Teachers were uniformly positive about how easy the materials were for students to read, and appreciated its visual aspects such as the visual dictionary of key vocabulary. They regarded the layout and photographs of the lab inquiries useful in allowing students to easily discern what materials were needed, and to enable students to work more independently.

Teacher –friendly materials

Teachers found the Teacher's Guide very useful, and easy-to-follow. They felt it offered a lot of different options for activities and teaching techniques, yet in a format and layout that was easily accessible and flexible. Teachers also liked that the materials required for the hands-on activities were generally easy to obtain and handle.

Integration of reading and science valued

Teachers were enthusiastic about the ways in which the pilot materials integrated reading and science, citing the importance of such an approach given district priorities in literacy and reading across the curriculum. Most teachers felt that the inclusion of reading instruction techniques enhanced their teaching of science to their students. Teachers particularly liked the K-W-L chart and other graphic organizers.

Interest in more opportunities for student writing

Teachers were generally positive about the various writing assignments in the student book and teacher's guide. Several voiced that there should be more opportunities for writing. All seven teachers created their own additional writing assignments to incorporate in their teaching of the pilot materials, including the use of science journals, written lab report forms, independent research projects, and creative writing assignments.

Scientific inquiry progression generally well-received

Teachers were generally positive about the progression of laboratory inquiries (going from directed, guided, to full) and the ways in which the materials addressed the 5 E's (engage, explore, explain, evaluate, and extend.) Teachers did express that, at times, the materials needed more depth and that labs needed a closer relationship to the scientific method, and data collection and analysis.

Well matched to standards, assessments and teacher needs

Teachers felt that the materials filled a need they had for themselves and their students, adequately prepared students for meeting their districts' science standards and standardized tests, and would be acceptable to teachers in their district as a core science program.

Desire for greater depth of materials and instructional approach

While teachers and students found the student book easily accessible and readable, a number expressed interest in materials that offered more scientific depth and detail for this age group. Similarly, teachers liked the scaffolded questions and lesson check points, but some found the questions more focused on recall and straight comprehension, rather than deeper or more inferential reasoning or extensions of scientific concepts or phenomena.

Need for more student activities

Given the inherently physical and spatial nature of the earth in space unit, several teachers supplemented the pilot materials with additional activities involving the students' actions and movements to model the sun, earth, moon and planets. They found such activities critical in helping students better understand the complex notions of rotation vs. revolution, orbits, and how the earth's seasons and day/night relate to its orbit around the sun.

Interest in deeper and more diverse range of assessment questions

This applied to "check points", scaffolded questions, and final chapter assessments. A number of teachers felt they needed more and "deeper" lesson check point questions, scaffolded questions, and end-of-unit questions so that they were more than short recall or straight comprehension questions. Types of assessment questions that teachers brought in from supplemental materials included essay questions, and more complex multiple choice questions that were visual in nature (to capture the visual-spatial learning central to the space unit), had multiple dimensions to each answer (e.g., dealt with both shape of orbit and placement of sun within that orbit), or had multiple solutions.

Value of materials in addressing teachers' time constraints

Teachers liked the clear layout and modular, flexible approach to the teachers' guide, given the time constraints they felt when teaching science in their classrooms. They appreciated the "quick" features, such as the quick summaries and quick activities. However, several pointed out that the "quick activities" often could take a full class period to complete, and that the time assessments indicated for the labs underestimated the actual class time involved.

Appreciation of inter-disciplinary connections

Teachers liked the ways in which the materials included activities involving mathematics and social studies. Teachers also appreciated the technology links, and opportunities for students to use the Internet to further their scientific learning.

Design Recommendations

Our formative evaluation results also point to a number of design recommendations, concerning the current and future versions of the Scott Foresman Intermediate Science curriculum. These design recommendations include:

Preserve the highly readable, engaging visual format

Students and teachers alike responded positively to the easy readability, interesting content, and attractive nature of student materials.

Maintain the user-friendly format of the teacher guide

Maintain its plentiful offerings of helpful classroom activities and its valuable utilization of literacy-related skills in the learning of science. Continue offering the modular teacher options and "quick activities and summaries", given its value to time-pressed teachers. At the same time, be realistic in the time likely to be required by activities, to ensure that most teachers can carry out "quick activities" in 15-minutes or less.

Maintain the integration of reading and science instruction

Teachers greatly valued and appreciated the consistent use of literacy strategies and approaches in the science text and science instruction. Look for regular opportunities to suggest use of common graphic organizers, such as K-W-L charts, and other tables and visual tools. Include teacher-posed questions that address more than students' straight recall of information, but incorporate more inferential reasoning, interpretation, draw upon prior knowledge, and make connections to the real world.

Increase the depth of information in scientific materials

While preserving the appropriate readability of materials, concisely provide more scientific detail and depth on key topics for the intermediate grades. This will addressed to some degree in the future *leveled readers,* which were not available for the pilot testing. At the same time, the basic student text might benefit from some additional information that is important for all students to learn and possess.

Keep the "scaffolded inquiry"

Teachers very much liked the progression of directed, guided, and full inquiry, and the use of the 5 E's. Consider providing some more depth and interesting variability in collected data for the directed and guided inquiry, so that investigation results are not always easily predictable, nor produce an identical set of results across all students (i.e., in which students always see the same thing, or get identical results.). Activities always producing the same result are more akin to "demonstrations" than student investigations. Variability in results can lead to interesting opportunities for data collection, analysis, comparison, class compilation of data, and discussion and interpretation of results. Consider including full inquiry activities in which students can pose their own research questions, and design their own experiments.

Add more student demonstrations, hands-on activities and investigations

Teachers highly value students' hands-on investigations of scientific concepts. This is at a somewhat higher priority level than straight teacher demonstrations and reading from science texts. Activities should include both labs and investigations, and active student hands-on activities and modeling of principles.

Strengthen connections between lab activities and the scientific method

Lab activities should better integrate data collection and analysis. Include opportunities to integrate mathematics and more quantitative data and analysis in lab experiments.

Incorporate greater opportunities for student writing

This is to enhance students' scientific learning and strengthen literacy skills. Writing opportunities could be of various forms, including written lab report forms, independent research projects, creative writing, and science journals. Teachers would also welcome well-designed student activity sheets and ideas for interesting writing assignments.

Increase, deepen and broaden the types of science assessment

This applies to "check points," scaffolded questions, and final chapter assessments. Assessment questions should not disproportionately emphasize straight recall questions, but include more open-ended writing responses, more multi-dimensional multiple choice options, and questions with multiple solutions. Questions should incorporate appropriate visual techniques (use of visual multiple choice options or students' schematic drawings) to tap highly spatial and visual information in the unit. Final manuscript checks should assure that last minute changes in scientific text content and terms is accurately captured in final student assessment sheets.

Continue to involve use of technology, and curriculum connections

Teachers greatly valued and appreciated ways in which the science text promoted students' technology use and allowed them to access greater information resources via the Internet. Cross-disciplinary links to other subjects provided interesting learning opportunities and applications of knowledge, and allowed teachers to utilize materials in more than "science-designated" time slots such as in social studies and mathematics.