ESTELL

Effective Science Teaching for English Language Learners

TEACHER HANDBOOK

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Introduction

English Language Learner (ELL) students are not well-served by our current educational system. For at least thirty years, the achievement of ELL has lagged behind that of native English speakers, and the gap continues to grow (Rodriguez, 2004). The underachievement of ELL in science is of particular concern. The most recent statewide assessment of science knowledge on the California Standardized Testing and Reporting (STAR) exams shows that ELL students perform the lowest of any subgroup, and ELL students are significantly less likely than their Anglo counterparts to pursue advanced degrees in science (California Department of Education, 2007; CPST, 2007) or to perceive science as relevant to their lives outside of school (Buxton, 2006; Hammond, 2001; Rodriguez, 2004). This bimodal pattern of K-12 and college student achievement in science is strongly correlated with the bimodal distribution of workers in the labor force, with ELL groups being overrepresented in low skill, low paid occupations and underrepresented in high tech and professional occupations (Maldanado & Farmar, 2006; National Council of La Raza, 2007). This is a significant problem for California and the economy because 40% of school age children are of Latino-decent, often sharing poverty, limited parent educational attainment, limited English proficiency, and underachievement in science (NGA Center for Best Practices, 2000; Rodriguez, 1997).

Integrating language, literacy and science learning

Many ELL do not have access to rigorous instruction in academic subjects and are often relegated to remedial instructional programs focusing on the acquisition of basic literacy skills and facts aimed at improving student English-proficiency levels instead of teaching high quality content (Garcia, 1988, 1993; McGroaty, 1992; Moll, et al., 1992; Pease-Alvarez and Hakuta, 1992; Valdes, 2001). However, a substantial body of research in the English language development literature has demonstrated that the integration of subject matter teaching with language and literacy development can enhance learning in both domains.

Science lessons are a particularly powerful context for learning language and literacy. In inquiry science, the use of language is contextualized by being related to objects, visual representations and pictures, hands on activities, and experiences with the local environment. By relating language and literacy activities to real life objects, events and activities the words have real meaning for students. In science lessons, students communicate their understanding in a variety of formats, for example, in writing, graphic representations and creating tables and graphs. Students also talk about science in science class--describing, hypothesizing, explaining, justifying, arguing, and summarizing—all of which support the development of science understanding and reasoning processes. Integrating science and literacy instruction synergistically promotes the development of English language, science literacy, and scientific understandings.

Cultural compatibility: Increasing student engagement through home-school connections

ELL students, however, not only face difficulties due to language barriers in schools, but must also cross borders between their home cultures and the school culture (Aikenhead, 2001, 2006). Whereas this transition is not a difficult one for most middle class Anglo students, it can be quite a formidable process for cultural and linguistic minority students. When students' experiences from their lives outside of school are incorporated in instruction, however, the transition between home and school is a much smoother one. Integrating student cultural knowledge, experiences, and interaction patters has been shown to improve the achievement and participation of linguistic minority students in science (Lee & Luykx, 2006; Stoll Dalton, 1995; Tharp & Gallimore, 1998).

ESTELL Instructional Practices

Building on the research on effective teaching for ELL, the integration of science, language and literacy, and the cultural compatibility research discussed above the ESTELL project has identified six instructional practices that have been demonstrated to improve the teaching and learning of English Language Learners: 1) Collaborative inquiry; 2) Science talk; 3) Literacy in science; 4) Language development; 5) Contextualizing Science Activity; and 6) Scientific reasoning and understanding through inquiry. These six practices are described in Table 1.

Table 1: ESTELL INSTRUCTIONAL PRACTICES

Collaborative Inquiry
The teacher promotes equitable participation and student construction of scientific knowledge through inquiry-based, collaborative activities. The teacher facilitates heterogeneous grouping and collaborations between students through the use of multiple cooperative structures, such as whole class, pairs, small groups, learning stations, jigsaws, etc. The teacher makes efforts to engage all students and ensures the equitable participation of English Language Learners in small group activities and whole class discussions. The teacher encourages students to share and own scientific knowledge, rather than relying on the text and teacher as the sole source of scientific authority in the classroom. The teacher encourages student production of scientific knowledge through probing and student-centered activities. He presents scientific knowledge as able to be challenged.
Science Talk
The teacher engages students in sustained discussions of science topics and assists students' develop oral expressions of scientific reasoning and argumentation. The teacher engages students in science dialogue by initiating conversation through the use of open-ended questions and probing students to discuss their ideas further. The teacher elicits and models conversation that requires scientific reasoning, encouraging sustained student discussion on science topics. She provides feedback on student use of science talk, such as the use of evidence to support their claims, proposing methods for investigations, etc. The teacher elaborates, revoices, and connects student ideas, and invites students to follow-up on others' talk.
Literacy in Science
The teacher both promotes science vocabulary learning and engages students in reading and writing activities that are authentic to science. The teacher provides students with opportunities to read and write in science, using written materials that are authentic to science, i.e. reading non-fiction readers, science news articles, science-based web sites, writing up investigation/experiment procedures and results, using

science notebooks, etc.). The teacher gives clear instructions on how to use these materials within class activities and provides feedback to the students on how they are using the materials (i.e. feedback on written assignments, guidance on how to use research materials on the Internet, etc.).

The teacher also introduces and uses key science terms (e.g., observe, predict) and science terms (e.g., erosion, adaptation, molecule) and ensures students have multiple opportunities to review and use those terms during the lesson. This can be accomplished through having the students keep a glossary, posting new vocabulary on a class word wall, etc. He also makes sure to check for student understanding of new terms throughout the lesson.

Language Development in Science

The teacher modifies and scaffolds instruction to help ELL students increase both their English language fluency and science content understandings.

The teacher modifies her talk through repetition, decreasing speed of speech, increasing wait time, rephrasing, etc. so that ELL students can better understand teacher instructions and new content. The teacher also gives instruction on English language development, such as figurative language, idioms, grammar and mechanics (i.e. cold/colder/coldest, "raining cats and dogs," etc.), and provides students with feedback on their English language usage. She consistently scaffolds science content instruction through the use of scaffolds and SDAIE strategies such as gestures, manipulatives, audio, visuals, demonstrations, word walls, graphic organizers, technology, and other instructional tools.

Contextualizing Science Activity

The teacher integrates students' knowledge and resources from their homes and communities through culturally responsive and socially relevant science instruction, and engages students in exploring science concepts within their local physical or ecological and global environments.

The teacher provides but mostly elicits from students examples and scenarios from their home, communities, and sociocultural experiences as a resource in science instruction. She incorporates students' questions or contributions related to personal-home-community and local-physical-ecological knowledge into the science lesson, and designs science activities or inquiry projects that build on relevant science issues in students' local and global communities. The teacher also references multicultural contributions to science.

Scientific Reasoning and Understanding Through Inquiry

The teacher encourages students to develop and use scientific reasoning through inquiry activities and investigations.

The teacher activates students' prior knowledge about science and makes clear connections between prior knowledge and new knowledge. The teacher is a facilitator through student-led inquiry activities. Students are provided with opportunities for presenting/sharing their work and evaluating the work of other students. The scientific inquiry process is promoted through student engagement in developing research designs, analyzing and presenting findings, and considering the implications of their investigations.

In developing the framework for ESTELL, the authors emphasized the importance of cultural contextualization in the effective teaching of diverse students and the importance of discourse and cooperative learning in promoting cognitive development. Activities are rich in language, with teachers developing students' capacity to speak, read, and write English and develop the special language of science. The curriculum is taught through meaningful activities that relate to the students' lives and experiences in their families and communities. Teachers challenge students to think in complex ways and to apply their learning to solving meaningful problems. Teachers and students converse: the basic teaching interaction is conversation, not lecture. A variety of activities are in progress simultaneously (individual work; teamwork; practice and rehearsal; mentoring in side-by-side, shoulder-to-shoulder, teacher-student work). Students have systematic opportunities to work with all other classmates.

ESTELL pedagogy is based on a decade of research on effective teaching practices for ELL (Amaral, Garrison and Klentschy, 2002; Baquedano-López, Solís, & Kattan, 2005; Bravo & Garcia, 2004; Cervetti, Pearson, Barber, Hiebert & Bravo, 2007; Doherty & Pinal, 2004; Estrada & Imhoff, 2001; Ku, Bravo, & Garcia, 2004; Ku, Garcia, & Corkins, 2005; Hilberg, Tharp & DeGeest, 2000; Lee, Maerten-Rivera, Penfield, LeRoy, & Secada, 2008; Saunders & Goldenberg, 1999; Saunders, O'Brien, Lennon & McLean, 1998; Stoddart, 1999; 2005; Stoddart, Abrams, Canaday, & Gasper, 2000; Stoddart, Pinal, Latzke & Canaday, 2002; Stoddart, Solis, Tolbert, & Bravo, 2010; Yore, Holliday & Alvermann, 1994, Wang and Herman, 2006).

Instructional Exemplars of ESTELL Instructional Practices

Below we present instructional exemplars of the six ESTELL instructional practices. Each section foregrounds a specific approach, for example, language and literacy or scientific talk – but each of these examples reveals a synergistic integrated, as opposed to an "add-on," approach or strategy for instruction. The exemplars include: 1) Collaborative Inquiry; 2) Science Talk; 3: Literacy in Science; 4) Language Development in Science; 5) Contextualizing Science Activity; and 6) Scientific Reasoning and Understanding Through Inquiry.

Collaborative Inquiry in Science Learning

ESTELL focuses on promoting effective learning communities through inclusive and collaborative student engagement. Collaborations occur between teacher and students but more emphasis is placed on student-student interactions in small groups or pairs. However, the role of teacher in collaborative inquiry is not passive. The teacher works closely with each group to ensure that all students are participating within their appropriate zones of proximal development; s/he monitors students' engagement with the task and scaffolds them through questioning and prompting to keep them actively interacting with both content and language. The teacher promotes the creation of learning products including artifacts, processes, procedures, or findings about science. The teacher supports student sharing, evaluation, and feedback of class products. Additionally, the teacher regulates the quality of the product, tangible or intangible, to ensure that students have accomplished both the science learning and the literacy and language learning goals at hand. Collaborations can take many forms: shared ownership, authorship, use, or responsibility for a collaborative product or tasks. In ESTELL, however, there is a particular disciplinary focus with regard to collaborations in science that promote: collaboration, sharing of science authority, and specific science productions.

Example 1: Physical science - 2nd grade

2nd grade students have been studying simple machines and recently completed an investigation with levers. Using lab materials, they explored the fulcrum, effort, and load of a class-1 lever. Students investigate the levers in small groups. Each group was asked to detail their findings from tests they conducted using spring scales to determine the relationship between the fulcrum, effort, and load of a class-1 lever. The groups enter their findings on a chart. As the groups work, the teacher goes around to each group to probe for more detailed responses, asking them to think through their ideas, to make predictions and justify them. Each group presents their chart to the whole class and discusses their findings. All group members participate in the presentation. The teacher leads the class in a discussion and helps them to identify shared conclusions across groups. Following this, the teacher asked the students go back into their small groups to further investigate how class-1 levers are used to form a see-saw, hammer claws, scissors, and pliers. Each group is given a different item – a model see-saw, a hammer, scissors, or pliers. Then, groups present their findings, explaining how levers are used to form the item their group investigated.

This example shows how the teacher promotes students collaboration where all students are involved in the levers activity with the clear expectation that students themselves can generate scientific observations and conclusions. Students produce collaborative products, and shared understandings of the relationship between fulcrum, effort and load of a class-1 lever. Concepts are then tied to common household items so that students participate in a contextualized application of knowledge produced in the first activity.

Engaging Students in Science Talk

Instructional conversations (ICs) are an example of an effective instructional arrangement for teaching students through dialogue (Dalton, 1998; Tharp & Dalton, 2007). ICs can be achieved by the teacher organizing the classroom to accommodate conversation, articulating a clear academic goal for guiding conversation, ensuring student talk is more prevalent than teacher talk, guiding all talk to incorporate students' contributions, monitoring student comprehension of their talk, and by carefully scaffolding dialogue. The teacher elicits and models conversation that requires scientific reasoning to involve students in sustained discussion on science topics. The teacher elaborates, recasts, and connects student ideas, and invites students to follow-up on others' talk. Students have opportunities to interact with peers and the teacher, and the teacher assists students' language development by questioning, listening, rephrasing, or modeling. (Chapin, O'Connor, & Anderson, 2003; O'Connor & Michaels, 1996). Through these group discussions students begin to examine and reformulate a range of ideas and develop more complex understandings (Baquedano-López, Solís, Kattan, 2005).

Example 2: Nature of science - 5th grade

Students in a fifth grade classroom have just completed an investigation into gravity and acceleration. Their question was: Do balls of different weights, masses, and sizes fall at different rates? Their results were inconsistent. The teacher leads the students in a discussion on experimental error related to the investigation.

Teacher: (to Student 1): Tell us what happened during your group's investigation.
Student 1: Well, we got different results for each trial. During two trials, all the balls fell at the same rate. During one trial, the tennis ball fell first.
Teacher: (to all students) Did anyone else experience this?
Student 2: Yes, the same thing happened in our group.
Students 3: We didn't.
Student 4: Our group found that all the balls fell at the same rate.
Teacher: Can anyone explain what might have been going on here? How is it possible that you could have gotten different results for each trial? Students 1 and 2 got different results, but Students 3 and 4 found that the balls fell at the same rate each time. What does that mean?
Student 5: Maybe they conducted the experiment wrong?
Teacher: What do you mean? How could the experiments have been conducted differently? You all have the same materials.
Student 6: Yes, but we went outside to conduct our investigation, and it was kind of hard to tell which ball was falling first. The ping pong ball was taken by the wind when we dropped it, which made it fall slightly after the other two.
Student 2: Well, it seemed like in our group we kind of expected the tennis ball to land first, so maybe we could have let that one go like half a second before the ping pong ball, you know? It's like we wanted it to win.

Teacher: So what could you do differently to eliminate these sources of experimental error next time?

The teacher in this example involves students in a scientific discussion on experimental error. His approach to questioning is such that he encourages students to respond to each other and engage each other in a discussion on the importance of precision and accuracy of measurement in a scientific investigation. He uses instructional conversation to encourage the students to reach this conclusion without giving them the answer directly.

Literacy Development in Science

ESTELL instruction around literacy development provides students with opportunities for reading and written activities related to a contextualized science activity. There is a particular focus on promoting authentic science literacy use (graphing data, recording observations, reading and writing expository texts, illustrations, etc.) using science reading materials/references/illustrations for learning science, the use of science language and the systematic use of scientific vocabulary. Opportunities for literacy practices germane to science provide a context for authentic uses of literacy and increase the likelihood that students will build fluency in these literacy practices.

Example 3: Life science – 2nd grade

The following example describes an elaborated implementation of the ESTELL approach in literacy development. All the ESTELL elements for the integration of science reading and writing are covered including attention to: authentic science literacy and science vocabulary use.

Ms. D., a 2nd grade teacher, engages the students in reading and writing about bees and pollination. Ms. D sits at front of the word wall with a large colored drawing of a flower and bee resting an easel on the side. The students are seated on a rug in front of her. Ms. D asks students to tell her what they see in the picture. Two students say they see a bee. The teacher asks the students to go to the word wall and find the word "bee" and take it from the word wall and put under on the picture of the bee on the easel. Then another students says, " I can see a flower." He goes to the word wall to find the word for "flower" and puts it on the easel under the picture of a flower. Ms.D asks students to see what they notice about the bees' legs. She repeats students' responses and asks them for more information. For example, one student says, "There is orange stuff on the back of his legs." Ms. D replies, "Yes, it's a yellow-orange powdery stuff called pollen." She asks students, "Where do you think the pollen came from?" A student asks if the bee got it from the flower. Then Ms. D. tells tell students about the bee's role in pollination as she points to parts of the flower and bee. Students respond with questions and comments about this process. The teacher says that they need to add two new words to their word wall: pollen and stamen and add those to the picture of the flower.

Ms. D then tells students that they are going to write a "morning message" together about bees, pollination and flower parts. Throughout the writing exercise, Ms. D points out the language structure of the message as they write it—for example, pointing to the beginning of the first sentence she asks students, "Why did I begin writing here instead of here? A student replies, "Because it's a story," and Ms. D says, "Yes, it's the beginning of a paragraph." The message *they write describes the pollination process and the function of the various parts of flowers in this process (e.g., the colors of the petals attract bees, the stamen contains pollen, etc.). Ms. D asks students to read the paragraph in English and Spanish, stopping to ask and answer questions as needed. Ms. D also leads students through a game where she asks them to identify words within the words in the "morning message" (e.g., "men" in "stamen").*

Ms. D then transitions into a hands-on activity—dissecting a flower. She tells students what the goals are for the activity and models the process for them. Ms. D places a large diagram of a flower and points to the flower parts on the diagram as she describes what she would like students to do. Students are told to create sections on their paper to place the flower parts. Each student is given one flower, a hand lens and paper. Ms. D and her teaching assistant help students as they work. Ms. D's interactions with students incorporate substantial inquiry discourse—she asks students to talk about the parts they identify, asking what the function of the part is, where they would find pollen, and so forth. Ms. D also helps students to make discoveries that extend beyond the assignment. For example, one student finds a "baby flower" and seed, and takes them apart, another uses her hand lens to compare the parts of her flower with a flowering plant in a corner of the room. After completing the dissection of their own flowers, placing the parts into categories and labeling them, students take their hand lenses and examine other students' flowers. Students appear to be very engaged in the activity, after completing the primary assignment students are seen using their hand lens to examine other students' flower parts and are heard discussing what they have found.

The design and implementation of this lesson uses a substantial amount of science inquiry and a range of language activities designed to engage students and advance their learning in science and language. The language and literacy activities are contextualized by being related to observations of pictures and examination of flowers. The lesson covers in-depth science and language content and the implementation provides students with an opportunity to reflect on their learning. Students are provided with tools to participate in both science inquiry and writing about that inquiry. While there was an initial focus on writing a "message" that does not correspond to scientific forms of data observation and recording, the teacher does relate authentic science literacy tasks by having students write about their pollination observations.

Developing and Scaffolding Language in Science

The development and scaffolding of language in science needs to address both English language development (ELD) and augmenting access to science content through specially designed academic instruction in English (SDAIE) strategies. To accomplish this, the teacher modifies and scaffolds instruction to help ELL students increase both their English language fluency and science content understandings. The teacher modifies her talk through repetition, decreasing speed of speech, increasing wait time, rephrasing, etc. so that ELL students can better understand teacher instructions and new content. The teacher also gives instruction on English language development, such as figurative language, idioms, grammar and mechanics (i.e. cold/colder/coldest, "raining cats and dogs," etc.), and provides students with feedback on their English language usage. The teacher also scaffolds science content instruction through the use of scaffolds such as gestures, manipulatives, audio, visuals, demonstrations, word walls, graphic organizers, technology, and others.

Example 4: Life science – 3rd grade

The following example describes how the role of the primary language can be instrumental to maintaining student engagement during science activities that often rely on technical or new science language. The use of the primary language is important when appropriate; it facilitates the development of conceptual understanding, and provides a link to the development of English as an additional language. In the following example, a third grade classroom is involved in the examination of plant life through an experiment using seed pods. This observation takes place mid-way through implementation of a lesson. The teacher begins this observation by eliciting several types of science knowledge and observations but principally by 1) having students review what they have learned so far in this lesson, and 2) having students make conceptual connections to observations, including making predictions of what they might observe next. The following exchange occurs after several previous student contributions.

> *Teacher: After they were pollinated, what changes did we see with the plants?*
> *Student: It start um the () the () petals they start to getting long they start to ()*
> *Student: I can't-*
> *Teacher: ((points to board) Fall off?*
> *Student: No <u>seca</u> I don't know how to say it in Eng-*
> *Teacher: Well, tell me in Spanish*
> *Student: Um <u>se secaron secaron</u> (translation: they dried dried)*
> *Teacher: <u>Se secaron</u> (translation: they dried up)*
> *Student: <u>Secaron</u> (translation: dried)*
> *Teacher: Muy bien se secaron (translation: good they dried up)*
> *Teacher: It dried and it fell off, right? (writes on board)*
> *Student: Yeah ((a few students)) – it dried and fell off.*
> *Teacher: Ok, then we started to see a part of the plant we'd never seen before.*

The student in this example is encouraged by the teacher to switch from speaking English to Spanish, which allows the student to participate in the sharing of observations about seed pods. The teacher repeatedly uses key science vocabulary while eliciting information and observations from students, including using such key words as: petals, pollen/pollinate/pollination/pollinated, buds, leaves, flowers, stems, roots, and seeds.

Contextualizing Science Activity

ESTELL pedagogy advances teaching beyond physical hands-on activities or isolated inquiry investigations and extends it to include the purposeful integration of students' *funds of knowledge* from home, school, or community (Gonzalez & Moll, 2002; Hammond, 2001, Ladson Billings, 1995; Moll, et al., 1992). These practices integrate culturally responsive instruction by contextualizing student learning. In general, activities are contextualized when students' knowledge from home, school, or community are purposefully integrated into the science lesson. The teacher relates science learning to the world that surrounds students and makes connections to local, regional and global science issues and investigations. The teacher may also initiate and develop science projects that promote student expertise and leadership in issues related to local physical, geographic, and/or ecological science phenomena (e.g. leadership/ activism in local environmental contexts). Whenever possible, teachers involve family and community members as science experts and/or in the investigation of community-related science issues.

Example 5: Physical Science – 6th grade

Pedro is a sixth grade teacher who works at a culturally diverse school in the Pacific Southwest Borderlands. He is very interested in helping students become aware of how large corporations make huge profits by having their companies in other countries and by paying workers there low wages for making products that are then sold in the US. He also wants to show students how they can become more critical consumers by testing the often inflated advertisement claims these companies make about their products. To this end, he creates a realistic problem-solving scenario in which students are to test the claim that a company (run by one of these large corporations) has created a thin and light winter "super sock" that can keep winter sports enthusiasts' feet warmer. Because this new product is made in a country that allows workers to be paid very low wages and benefits, it is a lot cheaper than winter socks produced at a local company in the students' hometown.

Therefore, students are asked to set up an experiment that will first test the company's claim that the newly created super sock can keep a person's feet warmer. (Note that this is a good activity for the teacher to integrate the use of learning technologies by, for example, making Vernier temperature probes available). For this activity, Pedro also provides small bottles (preferably small glass jars with one hole stoppers), socks made out of different materials, one set of nylon socks to represent the "super socks," and hot water. Students are encouraged to design the experiment in whatever way they want, keeping in mind the importance of having a control and making detailed notes of their design and their observations.

After conducting the experiment, students are asked to discuss the results and determine whether the company's claims about the super socks are correct. Students are also asked to experiment with different materials to see if they can come up with a new type of sock that could be locally produced and that could successfully compete against the "super socks."

Developing Scientific Reasoning and Understanding through Inquiry

ELL students can and need to be challenged to think critically about science concepts and topics to develop higher order understandings. Too often, ELLs are relegated to remedial instructional programs focusing on the acquisition of basic skills that supposedly match their English-proficiency level and are not engaged in intellectually challenging activities (Garcia, 1988, 1993, 1997; Moll, 1992; Valdes, 2001). ESTELL integrated language, literacy and inquiry science practices promote the development of English language and literacy while simultaneously promoting the development of students' scientific understanding. In ESTELL, the teacher designs activities that promote complex reasoning of science concepts by having students' make judgments about the value of data and consistency of individual and collective thinking. Students have opportunities to reflect and evaluate their own and others' scientific reasoning. Teacher designs and promotes student-led inquiry by having students share and evaluate their research design, findings, and implications of their investigations and the teacher provides feedback.

Example 6: Developing scientific understanding - Physical science in 3rd grade

The following example from 3rd grade describes a lesson on the scientific method using an activity with paper airplanes. The example scores high in promoting several ESTELL practices including collaborative inquiry and language development. In addition, it is an exemplary case of promoting complex scientific processes and thinking through guided inquiry that the teacher achieves.

The teacher opens the lesson by showing a 6-minute video that he created which 1) describes the concepts of air pressure and lift; 2) introduces the lesson in which students would develop and test out paper airplanes; and 3) introduces the three steps of the scientific method (i.e. hypothesis, experiment, and conclusion,), and why it was important for students to use it in this lesson. In the video, keywords are both orally and visually presented. After the video, the teacher creates a list on the board with students about the processes of scientific inquiry and what each means for their inquiry activity about flight. The teacher also explains how students should record their findings on their method worksheet, which includes sections for them to record their hypotheses, findings and conclusions. Students work in small groups to discuss, create and design three paper airplanes. When they complete their airplanes, they go into the hallway to test out each airplane twice and measure how far they flew. Students record their results and observe the flight tests of other groups. Students write down their observations on their method sheet and are asked by the teacher to, within their small groups, compare their hypotheses with their findings and generate some conclusions about why their airplanes flew those distances. Finally, students are asked to discuss within their groups if their hypotheses were correct and tie their findings back to the scientific concepts of air pressure and lift.

This lesson supports ESTELL practices that challenge student thinking because it orients students to more complex engagement of science concepts and supports the examination of student investigations through repeated feedback. The teacher provides clear expectations for testing out the merits of their observations, connects the scientific method to the activity, and structures time for students to discuss and evaluate their findings based on the initial standards for evaluation.

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