Studying Energy in a Middle School Classroom

Mr. Hirano teaches six sections of eighth grade physical science, ranging in class size from 26 to 33 students. Because his school implements a full inclusion program, Mr. Hirano's classes incorporate students with a wide-range of abilities, including special education students of varying abilities, nonnative language speakers, and gifted students. Mr. Hirano knows that unit design is the most important factor in addressing all students' needs. By designing open-ended projects and activities, he can address students' strengths and needs while building content understanding, self-management skills, and independence.

Mr. Hirano's classes are about to begin a 3-week unit centered on the theme of energy resources, called *Who Has the Power?* Students answer the Essential Question, *How do I make decisions?* while they learn the science concepts of the unit. Mr. Hirano wants students to reflect on how they make decisions related to scientific issues and refine their decision making processes to include research and critical thinking skills. Since his students are very excited about getting their driver's licenses in the next few years, this project helps students learn about energy resources as they choose a car to purchase. They select a format in which to present their decision making processes and reveal the car they have chosen.

Preparing for the Unit

Mr. Hirano begins this unit with assessments designed to tell him what experiences and knowledge his students have about energy concepts, what they can describe about their decision making processes, and how well they manage their own learning. The information he gains from the assessments helps him tailor the lessons and activities to his students' needs and experiences.

To determine his students' prior understanding about energy, he conducts a discussion about the following questions:

- *How can we use energy resources responsibly?*
- *How does technology impact the development of alternative energy sources?*
- *How are alternative energy sources developed?*

During the discussion, Mr. Hirano takes notes about the concepts students appear to understand as well as noting areas of misconceptions and missing knowledge. To prepare to meet students' needs related to the scientific content they must learn, he examines his unit outline and locates where students' misconceptions can be addressed. He also prepares a set of content objectives at varying levels for his students with learning disabilities. He then shares the objectives with the special education teachers who work with those students.

Mr. Hirano asks students to respond to the following questions in their journals:

- *How do I make decisions about science-related issues?*
- *How can I become a more independent learner?*

To obtain additional information about his students' decision making processes, Mr. Hirano places them into small groups. Then, he asks them to discuss what decisions they make about energy in their own lives and to justify their decisions. He notes the kinds of thinking students demonstrate as well as their

understanding of energy concepts. He uses this information to help him prepare explicit instruction in the thinking skills students need to complete the project.

Students Stories: Monica and Justin's Goals

To prepare his students to direct their learning, Mr. Hirano gives his students a self-direction checklist. In the following excerpt from a sample checklist, Monica, a gifted student, analyzes her skills:

I set goals that are possible but that challenge me and make me work hard.	*I usually do this. I had to learn sound-editing software to do my last project, which was hard, but I did it. Sometimes, though, I try to do things that are just too much for me, and I have to give up.*
I create reasonable timelines and meet deadlines.	*I usually meet my deadlines. I only finish things late when I have computer problems.*
I ask for and seriously consider feedback from different sources.	*I don't really like to ask people what they think of my work. It sometimes makes me mad when people give me suggestions.*
I learn from my mistakes and rarely make the same mistake twice.	*I learn from my mistakes with computers, but I don't always improve when I have problems with my fellow students.*

To help students become more in control of their learning during this project, Mr. Hirano asks students to look at their goals and reflection from the previous unit. He then instructs students to form a few new self-direction goals based on their answers to the checklist.

Monica's Goals

1. *I am going to ask Jenny for her opinion about my work because I respect her ideas, and I am going to consider what she says seriously and use some of her ideas.*
2. *I am going to write in my journal every day about what progress I have made and what I am going to get accomplished the next day.*

Justin, a student with moderate learning disabilities, works with his special education teacher to develop his goals for managing his own learning.

Justin's Goals

1. *I will make sure I have my materials ready each day when class begins.*
2. *I will slow down when I do my work and check over it before I turn it in to look for careless errors.*

Mr. Hirano keeps a copy of his students' self-direction goals and refers to the goals periodically as he conferences with his students. At the end of each project, students connect their goals to the next unit, and they do a final reflection at the end of the year.

Introducing the Unit

In the first part of the project, students research energy resources. Mr. Hirano chooses Web sites for students to use for their research. He specifically chooses sites of various levels of difficulty so that all students start with the essential information. Then, more advanced students can move forward at their own pace. Mr. Hirano asks

students to complete assessments on their content knowledge and record their responses as they work, so they, and he, can check their understanding.

Mr. Hirano supplements the Web investigation with lessons and activities in class on the scientific concepts students need to complete the project. He uses questioning strategies to involve all levels of learners by preparing specific questions and discussion points addressing the different levels of content objectives. He then carefully chooses which questions to ask to specific students. By asking different levels of questions about the content, Mr. Hirano knows where he must make adjustments. Sometimes, Mr. Hirano designates peer tutors to help struggling classmates. This requires building a community atmosphere in which all students feel safe learning from each other and respecting differences.

For the final project, students conduct their own research and present the decision processes they used to select the car of their choice. Before beginning this project, students create a project plan. First, Mr. Hirano distributes a rubric delineating the criteria for the project. Next, he asks students for their ideas about how they plan to show that they have understood the important concepts and done their best work. He includes several of their ideas in the rubric.

Mr. Hirano has noticed in the project plans of previous units that his students had trouble breaking down tasks into steps that could be accomplished in a class period or less. Because of this, they had difficulty monitoring their own progress effectively. For this project, Mr. Hirano takes some class time to explain and model how to break large tasks into smaller activities, such as conduct research, narrow a topic, locate resources, and evaluate resources. He also holds small-group mini-lessons for interested students on using technology to create flowcharts, diagrams, and forms that can help track progress.

As students work on their plans, Mr. Hirano conducts informal conferences with students. During the conferences, Mr. Hirano asks probing questions to help students refine their plans and address issues of scientific investigation. Mr. Hirano enlists the help of the support staff to assist students with special needs in completing their plans, but all students are encouraged to complete as much of the plan as they can by themselves and with the help of their peers.

Completing the Project

Students use the project rubric to self- and peer-assess their work as they create their projects. They consult with their groups at designated times to receive feedback and share information. Responding constructively to peers takes practice, and Mr. Hirano develops a special lesson on providing, receiving, evaluating, and using feedback. While groups are meeting, he observes each member, noting who needs help and extra instruction. Sometimes, he intervenes on the spot to model constructive feedback.

Mr. Hirano knows that individual research does not guarantee that students will learn the core curricular concepts for the unit. Therefore, Mr. Hirano supplements students' project work with a variety of student-centered activities to introduce and reinforce their learning about energy, conservation, and the environment. He uses instructional time to model investigating issues from a scientific perspective. He also demonstrates the kinds of skills students need to evaluate and interpret the kinds of data they will find in their research.

Mr. Hirano uses an observation checklist to record students' decision making processes while they discuss their projects with their small groups. The following sample excerpt from the checklist shows the kinds of information he collected about a group that includes Miranda, a student with mild learning disabilities, and Lucas, a nonnative language speaker:

	Becky	**Lucas**	**Miranda**	**Alex**
Seeks multiple resources with relevant information	*Has a nice variety, including an interview with a mechanic*	*Having trouble finding resources in Spanish*	*Using just one magazine article*	*Has a couple Web site articles*
Predicts consequences of choices on self	*Not observed*	*Yes*	*Not observed*	*Yes*
Predicts consequences of choices on others	*Mentioned cost for parent*	*Not observed*	*Not observed*	*Said his friends would like it if he chose a certain car*
Predicts consequences of choices on environment, related to consumption of fossil fuels and different kinds of pollution	*Made chart comparing cars' greenhouse gas emissions and explained how they would effect climate here*	*Said using less fuel will leave more fuel for others*	*Not observed*	*Says if he's driving fast enough he won't pollute the air*

After students have done their research, made their decision about the car they would like to buy, and reflected on their processes, they prepare to present their decision making model. Students should choose a format that lets them use their strengths and interests, and can best illustrate their thinking. They may create flowcharts with statistical information and formulas, graphic representations, media presentations, writing, or performances.

Mr. Hirano encourages students to include a component in their final project that challenges them. He encourages Gina, a student who is a gifted writer, to write a script that will be performed by friends. This allows her to use her strength and encourages her to take a risk by experimenting with video technology. Lottie, who has severe learning disabilities, needs to work on her writing, but she loves to draw. Mr. Hirano suggests that she create a graphic novel, which will give her practice on what she needs to work on while letting her do what she enjoys.

As students work individually on their projects and consult with their groups, Mr. Hirano circulates among students, observing their interactions and taking notes on their developing content knowledge. He also notes their collaboration, decision

making, and self-direction skills. Using his notes, Mr. Hirano plans more in-depth instruction around energy concepts and process skills.

Concluding the Unit

Mr. Hirano concludes the unit by asking students to write a detailed reflection about their learning about energy concepts, making decisions, and self-managing their own learning. He analyzes their answers to determine how individual students have learned the scientific concepts and process skills. He writes notes to himself that he can use when addressing the needs of all students in future units. Mr. Hirano uses three major strategies to ensure a unit addresses all levels of learners in his classroom while teaching self-direction skils:

- He frequently asks students to do projects that address the curriculum he is required to teach but allows students to make some decisions about the content they learn, how they learn it, and how they show what they learned.
- While students are working, Mr. Hirano continually monitors progress so he can address misconceptions and misunderstandings immediately.
- He organizes his teaching around activities and instruction that provide students with the skills they need to control their own learning.