Chapter 3 Schoolyard Ecology Leaders' Handbook

Build teachers' competence with inquiry

Overview

Teachers need to experience inquiry learning on real schoolyards for themselves. In this way, they discover key elements of the inquiry process while learning ecology and getting comfortable being outside. These experiences and discoveries, and the confidence that comes with them, are essential foundations for their schoolyard ecology teaching.

Key Questions:

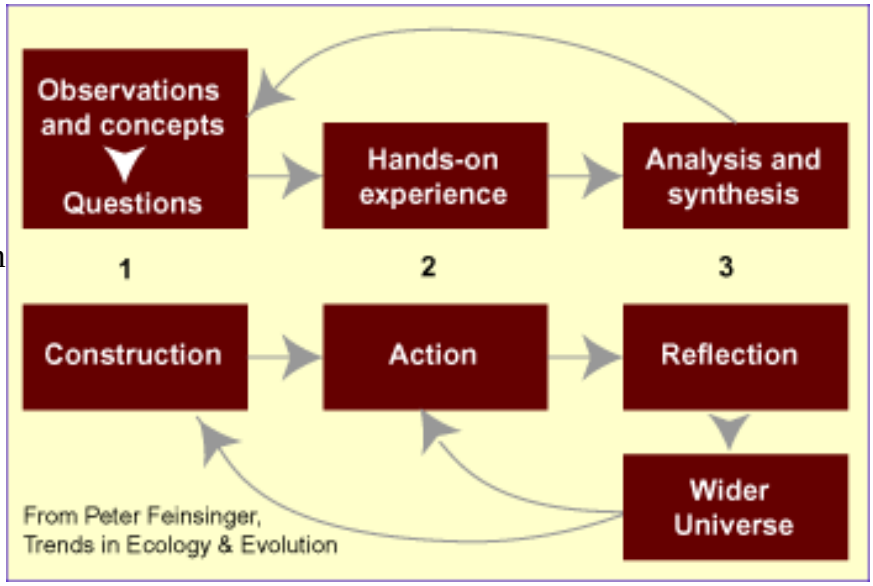
- *Why form a partnership?*
- *How to find a partner?*
- *How to make your partnership work?*

Next Page

Chapter 3 Schoolyard Ecology Leaders' Handbook
Build teachers' competence with inquiry

Background & Rationale

We included both inquiry and schoolyards in this chapter because the key strategy for building confidence in both is the same - direct engagement of the teachers in learning ecology on schoolyards. There is no substitute for learning first-hand about inquiry and about schoolyards. In this section we explore the thinking behind our approach to involving teachers in schoolyard inquiry, addressing these topics:



- How can teachers become better inquiry learners?
- Why do inquiry in a SYE Institute?
- What do we mean by inquiry?
- What are the different kinds of inquiry learning?
- Why do teachers need to do inquiry on their own schoolyards?

Teachers as Inquiry Learners

Teacher quote (from Boston SYEFEST): "I found I learned the most when I was the student and I was encouraged to observe my surroundings."

To be effective teachers of schoolyard ecology, teachers need:

- to understand the nature of scientific inquiry and how to use the skills and processes of inquiry for themselves
- to be knowledgeable about and comfortable in their schoolyard
- to be able to foster student learning through inquiry

Our approaches to fostering growth towards these goals start with an emphasis on teachers as inquirers. In an effective SYE Institute, teachers are active inquirers on their schoolyards, forming and pursuing questions that come from their own interests rather than being constrained by what might be appropriate or engaging for their students, or by questions given to them by "experts" or from a pre-set curriculum.

Familiarity with the ecology of their own school sites develops as a direct result of their own inquiries outside.

By engaging teachers in the **inquiry process**, we model a constructivist approach to fostering teacher learning. Thus, teachers' inquiries are framed around what they know, don't know and want to find out about a topic, and the group of colleagues and leaders together help them build the connections to larger understandings in ecology and life sciences.

During a SYE Institute, teachers are genuine learners and innovators. They are not trained to use a specific set of lessons, but rather are immersed in learning in ways that are similar to the ways their students might learn. One dilemma you will face as leaders of a SYE Institute is in crafting learning experiences that are appropriate for adults while also exposing teachers to activities that will appeal to their students. While it is virtually impossible to turn off teachers' practical thinking ("how might my second graders do this?"), it is essential for them to delve into at least some investigations that fully challenge and engage them as adults if they are to gain insight into the learning experience of their students.

One of the key strategies recommended in the following section is to teach the inquiry process explicitly. Teachers and any other learner benefit from clearly defined goals, and this applies to learning about the inquiry process as much as it does to learning about the organisms in the schoolyard. This is in accord with the Professional Development Standards defined in the National Science Education Standards and extensive literature on inquiry learning.

Why Do Inquiry in a SYE Institute?

- Motivation: Most teachers are hooked on inquiry teaching once they've tasted the excitement and intellectual rewards of learner-centered inquiry for themselves.
- Insight: What better way for them to get the enthusiasm and insights they'll need to try out what for many of them is a new approach to teaching?
- Modeling: To model the kind of inquiry teaching you hope teachers will adopt, you should use an inquiry approach to teaching them.
- Inquiry is the essence of science: The parallels between inquiry learning and scientific research are clear for a listing of different inquiry frameworks) Framework in Appendix 4]. Both scientists and the layperson use inquiry to build their understanding of the world around them. For more information on inquiry frameworks, see Appendix 4.

Teacher quote: I felt very worried about my general lack of scientific knowledge. Although I am still nervous about the upcoming year and my science program, I feel a new confidence in my ability to teach it. By using the inquiry method, I don't have to have all of the answers.

What Do We Mean by Inquiry?

Inquiry is question-driven learning. Query to alan: Two "cartoons" of the inquiry process are shown in [the diagram of Peter Feinsinger - included directly in text] and the Inquiry Framework in Appendix 4 [this is the learning_ab4 file I sent earlier and should appear as a link here]. Investigations of natural phenomena that follow from initial questions begin with developing ways to answer the question, and entail observation, sometimes manipulation, and then documentation using narrative or numerical data. Inquiry-based investigations culminate with summarizing, evaluating, and communicating findings in the context of known facts and theories. Making sense of the data in these ways brings the inquirer back to addressing the original question with possible explanations for patterns in data, and leads to making

decisions about what additional types of information will help in the next phases of addressing the same or a new question. In inquiry-based teaching, the phenomenon is the focus, rather than the teacher's preconceived activity plan. The question, whether it is their own original question or one suggested by the teacher or a classmate, frames and gives purpose to subsequent activities in inquiry learning. This is in contrast to hands-on learning in which activities may simply demonstrate a concept, explore a laboratory technique for its own sake, or provide opportunity for aimless exploration.

Using an inquiry approach to science teaching promotes complex learning, consistent with the National Science Standards referred to above and with other science education reform agendas. Learners actively explore scientific phenomena, engage in authentic scientific practices, apply skills and ideas to ill-structured problems, and experience in-depth immersion in important topics. Teachers also are expected to teach for understanding by recognizing that students' learning is influenced by their prior knowledge, skills, values, and beliefs, and that shaping the classroom as a community of learners who share goals, standards, trust, and academic values can make it possible for students to take risks and engage in sustained efforts that are necessary for meaningful learning. These tenets guide our work with teachers both by helping us choose goals and means for the teachers' own inquiry learning, and by providing guidelines for what teachers would eventually need to be able to do as facilitators of their students' inquiry learning.

One of the most important early goals for the SYEFEST family of Lead Teachers and Lead Ecologists was to craft their own vision for what inquiry learning means. At their Leadership Workshop in Gainesville, Florida, they came up with this definition:

Learners take responsibility for their own learning through active involvement and process including:

- observation using the immediate surroundings
- developing a question that matters to them
- devising a means to seek answers
- investigating, testing, and maybe failing
- re-testing and re-questioning
- analysis of results
- communicating and sharing results
- reflection on the process

The process proceeds at a pace that matches learners' level of understanding, experience, and cultural context. Curiosity and wonder set the agenda.

What Are the Different Kinds of Inquiry Learning?

One way of thinking about the different kinds of inquiry learning is to consider who directs or specifies each of the various components of the process. In the Table of Inquiry, we show a range of inquiry types, from the most open to the most guided. Some believe that increasing sophistication and achievement is required for the types of inquiry at the top of this table, while others point out that learners with a range of abilities and experience levels can tackle many if not all of these pathways.

Why Do Teachers Need to do Inquiry on Their Own Schoolyards?

Teachers need to learn inquiry by doing it. They need to get comfortable studying schoolyards by doing it. Studying ecology at a nature center, college campus, or even the schoolyard of other teachers has less direct

relevance than working on their own turf. Many teachers come into a SYE Institute thinking that their schoolyard is depauperate and barren. By successfully investigating ecology themselves on their school grounds, teachers discover the rich resource that was invisible to them before.

Top of Page | Background | Strategies | Further & Deeper | Resources | Chapter List | Contact Us
Table of Contents | Help | About IES | Search | Print | Forums | Home

Chapter 3 Schoolyard Ecology Leaders' Handbook
Build teachers' competence with inquiry

Strategies

The strategies for building teachers' confidence and competence with inquiry and schoolyards all revolve around direct engagement in a supportive atmosphere that fosters experimentation, reflection and growth. In this section we describe specific strategies for involving teachers in schoolyard inquiry:

- Create a supportive environment for inquiry.
- Have teachers do their own inquiries.
- Build teachers' research and inquiry skills.

Strategies described elsewhere - Teaching Ecology and Natural History, Chapter 4, and Reflection, Chapter 5, and Providing Useful Resources, Chapter 7, - also contribute to the goal of fostering teacher comfort and competence with inquiry.

Create a Supportive Environment for Inquiry

Create a supportive environment where teachers feel safe to question, hypothesize, experiment, stretch their minds, fail and succeed. An atmosphere of experimentation and reflection, where there is a shared sense of professional exploration, will go a long way towards helping teachers become inquirers. Perhaps most importantly for novice scientists, emphasize that is it not only OK to not know the answer, but that science is all about this very process of pursuing questions for which the answer is not known. Where would we be without someone saying, "I don't know?"

As teachers interact with practicing scientists that are involved in the SYE Institute as leaders or resource people, they should see first-hand how scientists think about the natural world, and how they generate and answer research questions. If done in a supportive way, the parallel between the scientist's thinking and the teacher's learner should help encourage inquiry.

Set positive examples of inquiry skills and dispositions by your own behavior. Show curiosity, care and excitement in observing patterns and puzzles outside, critical thinking in asking and evaluating questions, tenacity in the face of confusion and adversity, guarded skepticism when interpreting results, and the unbounded enthusiasm for increased understanding that all students of science share.

Creating a safe place for inquiry revolves around more than just the leaders' behavior and attitudes. The entire group of teachers can work together to build this safe and stimulating atmosphere. Have the teachers work in a variety of cooperative learning situations to foster positive group dynamics. These, too, are techniques the teachers will use with their students, and many already are quite adept at forming groups and nurturing various kinds of student cooperative learning. Assign the teachers to teams for projects, have them do peer review, do pair-wise exchange of rough drafts of inquiry plans for partner feedback, etc.

Lead Ecologist quote: One of my favorite parts of doing science is to wrestle with data once it's partially analyzed and available for examination. Then, you think back to the initial question and the big picture and you find out what "reality" has to say. This plays out when we give each other talks, with a thrilling back and forth that challenges the presenter to justify her or his claims, and challenges the listener to fit this new information into his or her established ideas. However,

I found this one of the hardest things for the teachers in our SYE Institute to get used to and comfortable with. When listening to each other's presentations about investigations, we would ask each teacher in the audience to come up with one comment … either a question, a positive result, or a suggestion … but most found this really difficult.

Have Teachers Do Their Own Inquiries on Their Own Schoolyards

Open Inquiry in the Schoolyard

Open inquiry - where learners frame their own questions based on their ideas about and observations of the world around them, and then go on to design and carry-out their own investigations - is a useful teaching strategy for many learners. Student ownership and motivation can be extremely high as they probe mysteries that they define and scope out. As they carry out their inquiries, learners taste the same thrill and challenge faced by scientists in directing their research. However, open inquiry can be challenging, both for the facilitators and the participants.

Challenges for Open Inquiry

Participants:

- Don't know how to ask questions.
- Are inhibited to write down "bad" questions.
- Need to know what things are before they write down questions.
- Are not used to observing and wondering.
- Are intimidated by experts in their group (leaders, other teachers who "know" more).
- Lapse into asking questions that aren't ecological.
- Think from their students' perspectives rather than their own.

Facilitators/Leaders:

- Relinquish control.
- Manage diverse projects.
- Hold back their own observations, questions, hypotheses.
- Interject wisdom from "the discipline."

This is a direct quote from the report written by the case study observer of the Boston site's work with open inquiry.

Three Ways Open Inquiry was Facilitated in SYE Institutes

1. Open Inquiry to Kick-off a SYE Institute. On the first day of a SYE Institute, soon after introductions are made, proceed outside with a question-generating assignment (see SYE Activity - Quadrats & Questions. Teachers - working individually, in pairs with each other (only 2, not more) or paired with an ecologist - generate a free-form list of questions about a particular part of a schoolyard. The leaders give quiet encouragement and help the nature-shy people get started, but otherwise they step back and allow teachers a lot of space. An amazing wealth of questions is invariably generated in a very short time, even by novice inquirers (see sample lists of questions generated by two teachers, Zoe Burke and Mary Hayes from Ocean View School with the St. Luis Obispo, California SYEFEST.) The teachers then are directed to choose a question - from among their list or a new one - that they can answer, and then they actually design and carry out a study. Usually, this whole process takes the entire first day, and sometimes spills into the second day, with teachers making their final presentations of results the next morning. By the time they complete a study based on one of their questions, many participants already experience a turning point in their confidence as inquirers.

In the middle of this open inquiry activity, the leaders play a crucial role in guiding the selection of the research question to be pursued by each group. One option is to discuss various ways to categorize the different kinds of questions we ask and to consider what makes some better for investigation than others. Some leaders prefer to give participants specific

guidelines ahead of time or at this point in the process, while others ask the participants to develop criteria for what makes a "good" question. The four criteria or guidelines for questions developed by Peter Feinsinger and colleagues are:

1. Questions should be **answerable** within a reasonable time limit, which can be specified as part of the inquiry activity. Questions such as "how?", "which?", "how many?", and "where" are likely to be answerable. In contrast, "why?" questions, while often more beguiling (and initially more natural to adults and schoolchildren alike), are rarely answerable directly through hands-on investigation. Instead, "why?" questions constitute the core of the reflection phase; they provide 'BIG PICTURE' motivation for answerable questions and are the key to generating additional inquiries (see Diagram of Inquiry). "Why?" questions often can be made answerable simply by dropping the "Why" but keeping the rest of the question.

2. Questions should be **comparative,** and the comparison should have some meaningful basis or general context involving (1) common sense and logic or (2) some prior inkling of general concepts leading one to expect the comparison to be of interest. A comparative question forces the inquirer to think about the rationale for framing it in that way (i.e., to specify the context in which the comparison is made) and leads to reflection (how do the results of the comparison relate to the general concept/context/chain of reasoning?). Non-comparative questions often are dead ends. Furthermore, even at the elementary school level a comparative question leads inquirers to think about study design, sampling, replication, the concept of a "fair test" - in short, the foundation for statistical inference.

3. Questions should be somewhat **tantalizing;** that is, they must involve neither an overly obvious, predetermined answer nor an overly tedious procedure. A question that otherwise complies with guidelines 1 and 2 could still be ineffective if (1) the answer is obvious or predictable at the outset, clearly signaling to the inquirers that they're just doing busy work; or (2) the answer is not obvious but the tedium of the data collecting necessary to answer the question far overwhelms the thrill for the chase and the potential for reflective learning.

4. Questions should **avoid jargon and avoid any technology** more sophisticated than materials commonly (and cheaply) accessible to school teachers and small children - nothing more sophisticated than paper, pencils, rulers, kitchen pots and pans and strainers, cheap fabric, string, rubber bands and markers. Forceps and magnifiers are borderline. Examples of scientific jargon not encouraged include Latin names of organisms and formal terms from ecological science (e.g., niche, eutrophication). If the question cannot be expressed in everyday language, it might not be worth pursuing.

A scheme that shows how these guidelines relate to a simple model of the inquiry process is included, too, in the "Designing Good Investigations" table on this page.

[INSERT FILE CALLED QUESTIONS_RULES]

Doing open inquiry on the first day of a SYE Institute doesn't necessarily have to lead to actual investigations. Just by encouraging open questioning, and then discussing the various kinds of questions generated, teachers begin to look at the schoolyard different and get a new glimpse of doing science. See also The Question Posing Activity devised by the Oxford Institute for Environmental Education.

[two quotes to put somewhere general in this section]
Lead Ecologist comment: Starting with an open inquiry was like putting a "quintessential example" of the most learner-centered form of inquiry-based teaching right up front for the teachers. Though for some, it was a real challenge, for everyone, it gave us something to refer back to again and again as one model for teaching.

Teacher quote: I hit a real wall when we had to write our own inquiry questions. I kept falling back to activity based questions that led nowhere. The first time I successfully completed one it was like lightening struck and the frustration vanished. I still feel a little overwhelmed by trying to incorporate inquiry into my methods!

For a wonderful example of how one SYEFEST teacher built on her experience with open inquiry and wove it into a unit with her fourth-graders, see the testimony given by Jude Curtin from her Millbrook SYEFEST experience.

2. Open Inquiry throughout a SYE Institute. In the Boston, Massachusetts SYEFEST, virtually every day provided some opportunity for teachers to do open inquiry. In only a few cases did teachers actually carry an investigation to

fruition, but every day had student-directed exploration, questioning, observing, documenting, organizing, comparing and collaborating in the open-inquiry model.

In the Oxford, Ohio, SYESFEST, teachers visited a different schoolyard each day (and sometimes, two schoolyards in a single day) and they spent the first 30 minutes doing open exploration of the new site and recording their questions. This model focused teachers on a different ecology theme each day, thereby constraining the questioning to some extent (see Ecology Framework in Appendix 4), thereby constraining the questioning to some extent - an example of the "type B - focused inquiry" in the Table of Inquiry. In some cases, discussions went beyond the questions to consider design of investigations, while in others, the list of questions became the entre into further discussion of the big ideas involved in the theme and of the opportunities for teaching on that schoolyard.

"Both Rob and Eric continually encouraged them to observe, watch and wait. They modeled for the teachers the need for keen observational skills, and emphasized the importance of teaching kids to 'stop and look, to watch and wait.' ... Slowly, teachers began to understand the importance themselves, and began to frame their questions in the manner that had been modeled: 'How do the ants, Japanese beetles, and bumble bees coexist on this one plant?' 'What are these plants that seem so attractive to the Japanese beetles, and why are there so many (beetles) here?' These types of open-ended questions then provided the spark for continued inquiry later in the lab. Teachers collected specimens in the small, clear plastic containers that had magnifying glasses attached and began to look closely at the bugs, beetles, and bees. One teacher remarked proudly, 'I collected my first bug today!' ... They began to observe critically and with a scientist's eye.

Rob was quick to point out: 'Part of science is knowing and another part is questioning when we don't know things. It's like solving a mystery, collecting quality evidence. How we deal with the uncertainty is critical because knowledge is relative, and many questions can't be answered. Kids need to know this, to experience this and be comfortable with this.'

"As the days progressed, teachers became more comfortable with 'not knowing' and with their ability to question: 'It's essential to hear scientists/ecologists say 'I don't know.'' Their questioning skills developed and became much more sophisticated as their experiences allowed them to frame their questions based on these experiences and inquiries."

- The range of big ideas you'd like teachers to learn something about,
- a diversity of research methods, for example:
  - carefully controlled, manipulative studies
  - short- and long-term comparative studies
  - environmental monitoring
  - indoor studies using materials collected from the schoolyard
  studies with model systems or models
- Different strategies or approaches to "guiding" inquiry, to serve as models for teacher practice giving the question:
  - giving the methods
  - giving the site or sites to study
- Designing good investigations
- Hypothesis formulation and testing
- Random sampling
- Replication and sources of variation in ecological studies
- Identification of research organisms
- Sampling techniques for animals (insects, worms, small mammals, birds)
- Data analysis and interpretation
- Graphing and data presentation
- Coping with the vagaries of ecological studies, including incomplete information, zeros, "failures," missing numbers and surprises

Some ways for building teachers' skills in these areas include:

- Readings
- Mini-lectures by the Lead Ecologist, or by each other
- Mini-workshops in skills, such as data analysis or plant identification
- Peer review of research plans
- Assign teachers to write up a research project and provide feedback on their papers.
- Selection of inquiry activities that develop specific skills (for example, the Millbrook, New York, SYEFEST used the Dandelion Determination activity to build teachers' familiarity with sampling schemes)

3. Open Inquiry as a Culminating Experience in a SYE Institute. In the "Tucson, Arizona, SYEFEST, teachers experienced a number of more guided inquiries leading up to a day and a half challenge to carry out an investigation on their own. This worked really well.

Guided Inquiry and the Schoolyard

Guided inquiry to maximize teacher learning is the learning environment in which leaders either (1) provide a strong focus for observations and questions or (2) constrain students to use particular sites or tools; the latter is probably the most common form of inquiry teaching both in SYE Institutes and in schools. While open inquiry often was used to help teachers better understand the inquiry or research process, guided inquiries were chosen to develop specific content understanding at the same time it fosters understanding of science process.

More about the criteria for selecting guided inquiries in terms of intended content learning is discussed in Chapter 4. Here, simply consider:

1. Guiding guided inquiry to maximize teacher learning. [*Coming soon...]

2. Smorgasbords of inquiry. In the Millbrook, New York, SYEFEST, teachers participated in a smorgasbord of Autecology Inquiries can be found in Appendix 1 - on days 2, 6 and 9 of the Summer Institute. Teachers in small groups rotated to three stations where the Lead Teacher, Lead Ecologist or third leader (in this case, a project coordinator) led them into a guided inquiry. In this case, inquiries were selected to (1) relate to the overall theme for this portion of the workshop - understanding autecology, or the adaptations organisms have to features of their environment, and (2) demonstrate kinds of research where the results unfold over several days. After collecting results on the second day (day 6 of the workshop), teacher teams selected a single topic from among the three to pursue through a follow-up study completed on day 9. This provided additional modeling of the research process where several rounds of investigation and refinement take place over time.

A Progression of Inquiry in the Schoolyard

Get teachers involved directly and often, and use a diversity of models for engaging them in inquiry (e.g., from guided to open inquiry, or from open to guided and then back to open inquiry). In doing this, develop a strand of your SYE Institute that carefully builds teachers' inquiry skills in a logical and progressive fashion, moving from more dependent and simple tasks towards increasing autonomy and challenge.

One teacher reflected, "For me, the activities have gotten more interesting and comfortable each day. The concept of "population" helped organize what we were doing and put it in a context where I could use it (and will be more likely to remember it.) I seem to need to know 'What's the point?' I seem to need a theoretical framework to hang things on. Otherwise it's kind of like busywork. . .something to do - but what does it mean? Does open inquiry work best late, rather that early, in a unit? For learners like me at least, I think this is the case." For more from this teacher, see Peggy Hansen's testimony in Appendix 5. Three models of inquiry progression follow: [*Coming soon]

1. Guided to open.
2. Open to guided.
3. Open to guided to open.

Building Teachers' Research and Inquiry Skills

As teachers grow as inquiry learners, they benefit from explicit training in research skills. This training needs to be woven into the sequence of inquiry activities throughout the SYE Institute, and can be hard-wired into the agenda or arranged in response to needs as they arise. Skills that might be addressed include: Ultimately, leaders should help teachers build their own conceptual framework for what they understand to be "the inquiry or research process," and relate this to traditional and contemporary models of "the scientific method." The inquiry frameworks in Appendix 4 should be helpful as references in this regard.

Top of page | Background | Strategies | Further & Deeper | Resources | Chapter List | Contact us
Table of Contents | Help | About IES | Search | Print | Forums | Home

Chapter 3 Schoolyard Ecology Leaders' Handbook

Build teachers' competence with inquiry

Further & Deeper

*Coming Soon ...

1) Inquiry and the "scientific method":
   a. Parallel with inquiry learning
   b. Poppers sciences

2) Inquiry and understanding:
   a. The essential interplay between the inquiry process and conceptual understanding b.Dispel the myth that process is all that matters or that science process can proceed usefully without science background or knowledge. c. Going beyond the idea that all teachers need to do is to get comfortable with saying, "I don't know"
   d. Recognize that the quality of teachers' own investigations, and the extent to which these lead to important learnings, all must build on their knowledge base of:
      - of inquiry
      - of ecology
      - organisms/natural history

3) The challenges of transfer:
   a. Open inquiry might be more appropriate for teachers than for students?
   b. Few teachers actually did open inquiry with their students.

4) When the school site really does limit inquiry:
   a. Vignette about a site enhancement project that fostered inquiry-based teaching.

Next Page

Top of page | Background | Strategies | Further & Deeper | Resources | Chapter List | Contact us
Table of Contents | Help | About IES | Search | Print | Forums | Home

Chapter 3 Schoolyard Ecology Leaders' Handbook
Build teachers' competence with inquiry

Links & Resources