

MAKING

SCIENCE

MENTORS

MAKING SCIENCE MENTORS

A 10-Session
Guide for
Middle Grades

Bernie Zubrowski, Vivian Troen, and Marian Pasquale

 Education Development Center, Inc.


National Science Teachers Association



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HANDOUTS AND OVERHEADS

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To develop an effective pilot program, we looked for the advice and wisdom of those with expertise in mentoring and those with middle-grades science expertise. Among the best counsel came from experienced science teachers who were “volunteered” by their school districts to be part of the first EDC Middle-Grades Science Mentoring Program. We owe profound thanks to the mentors, the teachers they mentored, and the administrators who supported their participation. The mentors included Mary Archambault, Brenda Busta, Michael Chace, Robert Correia, Susan Dost, Maria Drobiak, Ellen Forman, John Hodsdon, Nancy Hsu, Denise Kochanski, Laura Krich, Roseanne Kurposka, Tammi LaFleur, Priscille LeBlanc, Carol Mardeusz, Pegeen Moreau, Cynthia Quaratiello, Patricia Shattuck, June Thall, Michele Torkomian, Nancy Voght, and Cindy Wrobel.

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Most of all, we thank our colleagues at EDC’s Center for Science Education and the team who lived with this program and guide for days, months, and years. Barbara Brauner Berns and Catherine McCulloch worked expertly and tirelessly on both the pilot program and the guide. Millicent Lawton oversaw the writing and editing of the manuscript. Silvia LaVita, Matt Maguire, and Kerry Ouellet provided support in manuscript production. Martha Davis and Karen Worth gave us feedback on early drafts of the manuscript. Beyond EDC, we also thank Peter Sasowsky for his work on the CD-ROM and DVD and Kim Elliott for her production assistance.

As science becomes a higher priority in schools across the country, we hope that attention will be paid to preparing teachers new to teaching middle-grades science. They should all have mentors, and professional development for those mentors is critical. We hope this guide provides a framework for this very important work.

Bernie Zubrowski, Vivian Troen, and Marian Pasquale

A DIFFERENT APPROACH TO MENTORING

This mentoring program is different from others with which you may be familiar. Some mentoring programs cast mentors in social and emotional support roles. Others focus solely on science content. As important as those things are, we chose to create a different kind of mentoring program for middle-grades science teachers.

The National Science Education Standards place significant emphasis on inquiry in teaching and learning (NRC 1996). Just as the field has advocated inquiry-based science teaching, so, too, must we think in terms of an inquiry-based approach to mentoring. Our program uses inquiry as a common thread interwoven among science content, science pedagogy, and mentoring skills. We call this unique fusion inquiry-based mentoring.

Experience has taught us that good science mentors aren't born; they need to be prepared to be good science mentors. We also believe mentors need to have a strong background in science content and science pedagogy before they begin to support other teachers. Finally, mentors need to learn to communicate in a certain way about teaching in order to be effective in guiding their mentees.

Using this guide, you will master inquiry-based mentoring and share it with mentors, who, in turn, will share it with their mentees, all in the name of improving the classroom experiences—and achievement—of students.

ABOUT THIS GUIDE

Overview

This guide will enable you, as a facilitator, to prepare science mentor teachers from a wide range of backgrounds to support teachers new to middle-grades science. In your work with these mentors, you will model an inquiry-based approach to teaching and learning. The mentors you prepare will, in turn, share this approach with their mentees—who may be recent college graduates, career changers, or new to teaching at the middle grades—and support them in using it with their students.

The program presented in this guide is an adaptation of one designed and facilitated by our team at the Center for Science Education at Education Development Center, Inc. (EDC) in Newton, Massachusetts. EDC's Middle-Grades Science Mentoring Program was a three-year project funded by the National Science Foundation from 2001 to 2004. We piloted the program with more than 50 experienced and new teachers in nine diverse Massachusetts school districts. After we completed the pilot, we adapted the model, by request, for use in several other locations around the country, and we have further adapted it for your use.

In this guide, we describe a one-year program. Although our original pilot project in Massachusetts took place over three years, we realize that most districts and schools cannot allocate such a long period to preparing and sustaining mentors. Thus, we have modified our original mentoring preparation program to fit within one year.

We expect that this guide will be used by facilitators, who, like you, might be a teacher leader or coach, a curriculum coordinator, a department chairperson, a science specialist, a college or university faculty member, or a consultant. You can offer this mentor program as part of a larger project or as a stand-alone initiative of a school, school district, consortia, intermediate agency, or state.

This guide offers some tips for getting a program started (“Getting the Program Started,” p. xxxiv), but we cannot anticipate every kind of situation in which this mentoring program might be put to use. It is not within the scope of this book, for instance, to address local policies, politics, or funding issues that may be particular to your situation. We hope you will adapt the guide to fit your specific needs.

Parts of the Guide: What You'll Find Inside

“About The Program, starting on p. xviii, describes the mentoring program. We present the introductory description of the mentoring program in three formats: at a glance, in brief, and in detail. The introduction moves on to describe topics related to getting the program started and to program evaluation.

The introductory section is followed by the lesson plans. These plans guide the facilitator step-by-step through each of the 10 day-long sessions of the training institute that make up the program for creating middle-grades science mentors. For ease of use, each session is self-contained, so that everything the facilitator needs to run that day's session is described in that session's pages.

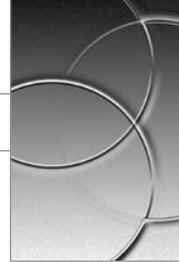
The lesson plan for each session contains the following features:

- 1. A Session Overview.** The Session Overview provides a brief description of the topic and purpose of the session and its intended outcomes.
- 2. A Session Snapshot.** The Session Snapshot includes the Agenda for the session. It tells you what you need to do to prepare in advance for the session, and it lists the materials and equipment you will need. (All materials and equipment are inexpensive and commonly available.) Each Snapshot also includes a media list, which details all of the session's overheads, handouts, and video clips, if any. The video clips may be found on the DVD accompanying this guide. The handouts for each of the institute sessions appear both in paper form in Appendix C and in electronic form on the CD-ROM that also comes with this guide.
- 3. Descriptions of Activities.** For each session, following the overview and snapshot, we provide a highly detailed description of each day's lesson, starting with a welcome period. These descriptions include *training tips* to help you guide mentors' explorations and reflections, *discussion points* that you can refer to as you introduce concepts and activities, and *science background facts* to help you inform mentors' science investigations. The activity descriptions also contain information on how to use the video clips in the context of the sessions, oversee reflection about the day, guide mentors' preparation for the next session, and conduct a brief session evaluation.

This guide wraps up with three appendixes—The Planning and Observation Protocol, which is unique to this program; a list of resources; and Handouts and Overheads.

On the DVD accompanying this guide are video segments we have produced. They provide examples of standards-based science teaching and allow mentors to develop a common understanding of, and language for, describing high-quality classroom teaching. On the CD-ROM, read the “User's Guide” first. As mentioned, the CD-ROM contains printable

electronic copies of all of the handouts and overhead transparencies that are to be used in the sessions. It also contains more information on the mentoring program, an “Inquiry Framework,” credits and acknowledgment, and transcripts of the material on the DVD.



The Venn Diagram

The graphic, reproduced in slightly changed form at the beginning of each chapter, (see Figure 1, p. xvi) provides a visual guide to our model of mentoring. It is a modified Venn diagram, showing the components of and relationship between the two major parts of the EDC Middle Grades Science Mentoring Program: science teaching and mentoring. The Venn diagram sits inside a larger oval representing the basic principles and practices underlying the professional development model.

The Outer Oval

In the model, all teaching and learning is grounded in four basic principles and practices:

- 1. Questions.** Forming and asking questions and investigating answers to those questions drives learning. Helping someone improve his or her ability to form, ask, and investigate worthwhile questions in a focused area of study is the work of teaching and mentoring.
- 2. Collaborative Learning.** Learning is a dynamic and fundamentally collaborative activity. Collaborating with another person allows learners to add the skills, knowledge, understandings, and labor of that other person to their own sets of learning resources and abilities. Together, learners can develop understandings they would not be able to develop alone.
- 3. Standards.** Standards can provide a unifying framework within which to focus our teaching and learning efforts. We can refer to specific standards when deciding what to do and how to do it, as well as when we want to assess how well we are doing something. To be truly effective, standards must be understood and accepted.
- 4. Formative Assessment.** Formative assessment supports our efforts to evaluate our relationship to a goal, adapt our strategies and practices in an effort to progress toward that goal, and even refine or change the goal. We continually assess our progress in teaching and learning through an iterative process of formulating questions, investigating data in the search for answers, evaluating results, and forming new questions based on those results, all within a set of standards.

The Left Circle

Science Teaching Content and Pedagogical Content Knowledge

The left circle represents the science knowledge, skills, and processes that teachers need to know to help students improve their science knowledge. For example, students need to understand the concepts of heat transfer. For teachers to help students gain that understanding, teachers must understand the concepts themselves and know how to create experiences that help all students learn the concepts, assess whether any particular experience is effective in this regard, and adjust or move forward accordingly.



The Right Circle

Science Mentoring Content and Pedagogical Content Knowledge

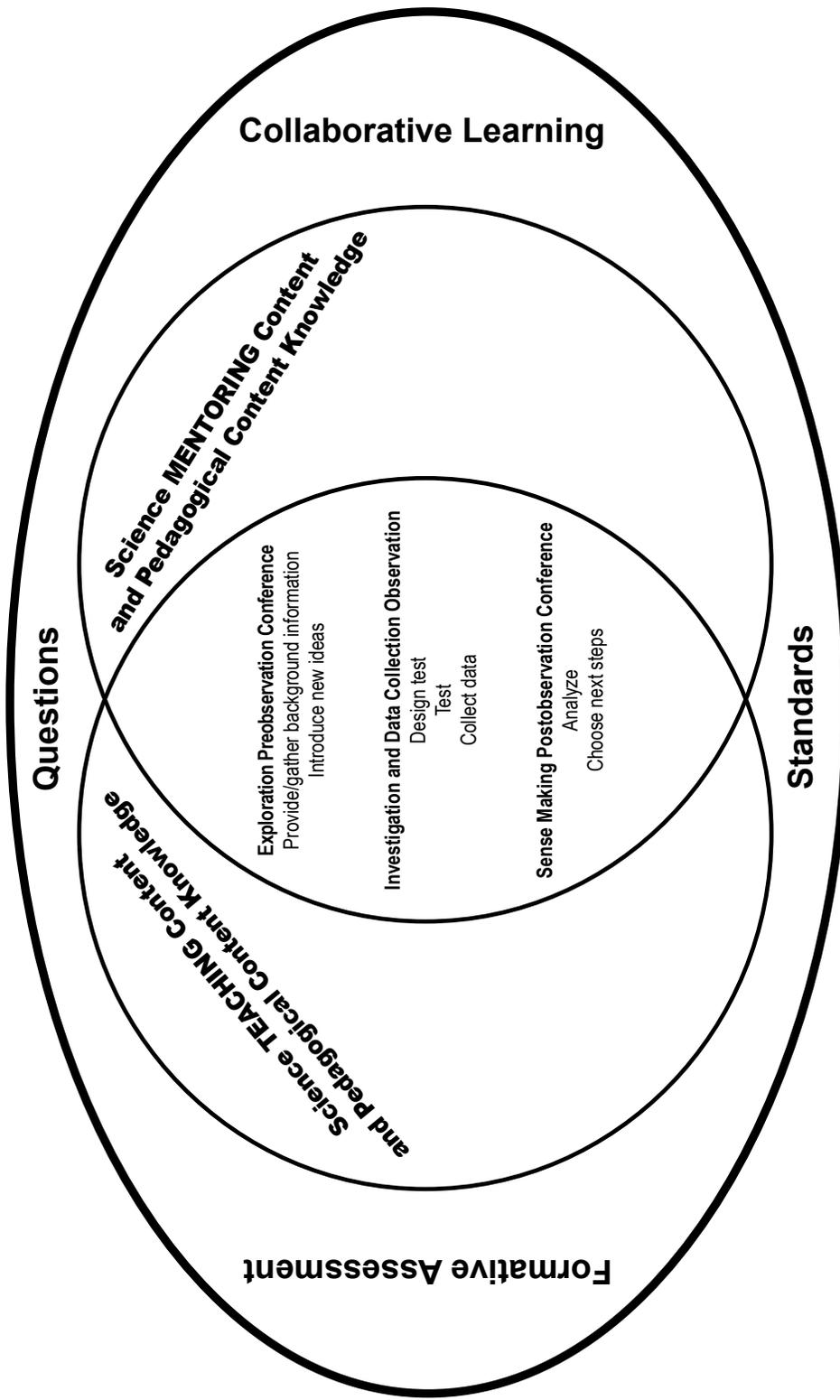
This circle represents the science mentoring knowledge, skills and processes that teacher mentors need to know to help teachers improve their science teaching. For mentors to help teachers gain the understanding of how to best teach their students particular science understandings, knowledge, skills, and processes, the mentors must understand these things themselves and know how to create experiences that help teachers learn to assess whether any particular experience has resulted in the lesson goals and adjust their teaching or move forward accordingly. For example, a teacher working on a heat transfer unit may want to investigate whether or not his or her questions are eliciting the type of thinking he or she believes will help the students move to the next level of understanding about the concepts involved. A mentor will need to assess the teacher's background knowledge of questioning, work with the teacher to develop effective experiences to provide knowledge, collect data on the teacher's current questioning practices and student responses, provide feedback to the teacher in a way that supports the teacher to gain an understanding about what is involved in effective questioning, assess whether the teacher has been effective based on the teacher's goals and the students' responses, and plan how to proceed. The mentor needs to keep in mind the goals for student learning and teacher learning at the same time, while also assessing the mentor's own effectiveness in helping the teacher, and, ultimately, the students.

The Center

The Overlap of the Science Teaching and Science Mentoring Circles

The overlapping area in the center represents the ways in which teaching and mentoring practices overlap in our model. As described above, students, teachers, and mentors are engaged in a process of learning. Each group is forming and investigating a question, collecting data, and evaluating and making sense of the data—the steps of inquiry. In mentoring, the steps of this inquiry process are labeled preobservation conference, observation, postobservation conference. Each group is simultaneously involved in the content members are learning and in the processes by and through which they learn. The teacher and the mentor first evaluate the background knowledge of the respective learner—student or teacher—and provide some information or experience to ready the learner for the next step. The teacher or mentor then helps the learner investigate and collect information about some aspect of the content or problem under consideration, such as heat transfer or effective questioning. The teacher or mentor then helps the learner make sense of the information the learner has collected. The processes of learning are parallel; the content differs, though both teacher and mentor need to keep all the learners in mind. A mentor must consider the students' and the teacher's needs for learning, as well as the mentor's own.

Figure 1. The Venn Diagram



ABOUT THE PROGRAM

The Program at a Glance

Who?	<p>Mentees: New to teaching and/or new to middle grades and/or new to science.</p> <p>Mentors: Five years of science teaching experience; experience in inquiry instruction in middle grades; solid content knowledge; experience doing professional development or working with adult learners.</p>
What?	<p>Inquiry-based Mentoring. Program interweaves science content, science pedagogy, and mentoring skills, using inquiry as a common thread. Follows National Science Education Standards emphasis on inquiry.</p>
When and How Long?	<p>Minimum of one year (with follow-up sessions thereafter).</p> <p>A. Four-day summer mentor preparation institute, followed by a school year of monthly or bimonthly institute sessions and time in school with mentees.</p> <p>B. If the above plan is not possible, mentors can attend program institutes during one school year, practice mentoring with peers, and take on mentees the next year.</p> <p>After the end of either yearlong formal program, mentors continue to meet monthly as a group.</p>
Where?	<p>On- or off-site training sessions and in-school mentoring.</p>

The Program in Brief

Philosophy

Our mentoring program aims to create a professional development experience rich in content, guided by *National Science Education Standards* (NRC 1996) and the *Benchmarks for Science Literacy* (AAAS 1993), and focused on enhancing both teachers' science content knowledge and their practice. The program uses inquiry as an explicit common ground between science teaching and mentoring methods. In other words, it is based on the idea that deep examination of practice by mentors and mentees is inquiry.

Components

You will facilitate the following parts of the program:

- **Training institute sessions.** Each of the 10 sessions lasts a full day, five to seven hours, for a total of approximately 60 hours of preparation. The sessions are built around the hands-on use of published science curricula that target concepts recommended by the National Science Education Standards for grades 5–8. We have selected those institute sessions from our pilot program that we believe are the most critical in terms of developing mentors' familiarity with science content, pedagogical content knowledge, and mentoring skills and strategies. The institute sessions are intended for mentors, but mentees may join in the later sessions.
- **Study groups.** These small discussion groups for mentors, held monthly or biweekly, supplement and complement the training sessions. Study groups enable mentors to reflect on their own practice and that of others in an informal setting.
- **Mentoring activities.** These include both the skill-building activities contained in the institutes and the real-world, in-school mentoring. Guided by the protocol (see Appendix A, The Planning and Observation Protocol), mentors may begin working with mentees as soon as Session 5 and continue doing so throughout the school year. Mentors and mentees should meet formally at least once every two weeks. One meeting a month is acceptable, as long as it is supplemented by informal communication such as e-mails, phone calls, and drop-ins.

Recommended Timetable

We advise that you carry out the sessions and activities on the following timetable:

1. Begin the mentor training during the summer, and offer the first four mentor training sessions (four days) together in a block. By completing these sessions, mentors experience one complete science unit as adult learners, including the development of key science concepts and the inquiry learning cycle. Mentors also acquire the fundamental mentoring strategies and skills that will enable them to begin mentoring that fall.
2. As the school year starts, mentors should use the same science unit from the summer institute in their own classrooms. This allows them to apply their knowledge of, and experience with, the

inquiry learning cycle before they continue with the rest of the sessions, attend study groups, or work with their own mentees. (We used this approach during the pilot project, and it was invaluable for helping mentor teachers develop a better understanding of the science concepts and inquiry pedagogy. When all of the mentors in training teach the unit at the same time, they share a context that results in rich discussions during training sessions and study groups.) If mentors do not have their own classes, encourage them to borrow a class from someone.

3. Hold Session 5 early in the school year to provide a bridge from the summer session experience to the mentoring work, and begin the study groups at about that time. Mentors' work with mentees may commence after Session 5.
4. Offer sessions 6 through 10 as bimonthly weekend institutes (on a Friday and Saturday, for instance, to limit teachers' time away from the classroom). Or you could present them as one-day sessions each month or use whatever schedule works in your particular context. In any case, alternate the sessions with study groups (held monthly or every two weeks), so that there is some kind of mentoring program activity on a monthly basis to maintain momentum and familiarity. As a forum for examination of practice, the study groups help mentors immediately apply in their classrooms what they are learning in the institute sessions.

Following the first year of institutes and mentoring, mentors should come together once a month to discuss ongoing issues and challenges. The program director or facilitator or a principal or district-level science administrator could run these forums—or the mentors themselves could rotate leadership.

Alternate Program

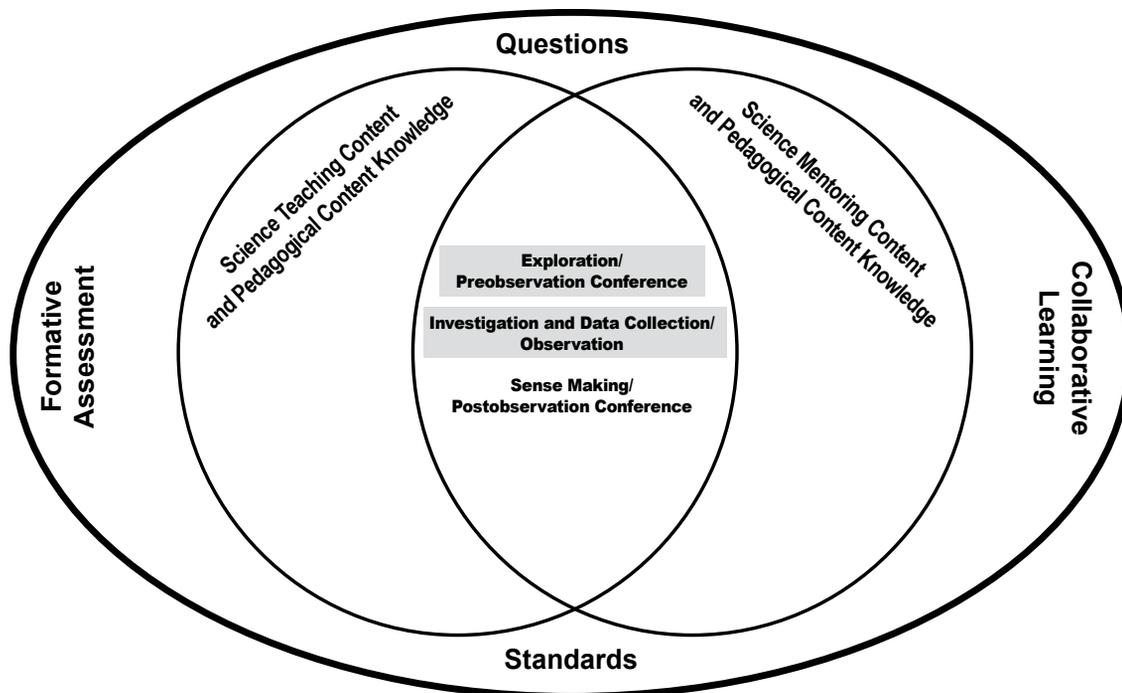
If you cannot implement the program in the way described, you can use the following option:

1. **Begin the mentor preparation program with the start of the school year. Hold sessions every other month (some during weekends), and convene study groups in alternate months until all 10 sessions have been completed.**
2. **As soon as possible in the school year, but certainly by Session 6, mentors should begin using the science curriculum unit from the earlier training sessions in their own classrooms.**
3. **After Session 5, have the mentors start to practice mentoring with a peer mentor from the institute sessions.**
4. **At the beginning of the next school year, assign mentors to take on mentees. We suggest a mentor work with a mentee for at least a year.**
5. **It is helpful for mentors to continue meeting as a group on a monthly basis to discuss their mentoring experiences and to provide each other support.**

SESSION 1

The beginning is the most important part of the work.

Plato, The Republic



Overview

In this first session participants get to know one another and begin to build a community of learners. They are introduced to two important tools—the inquiry learning cycle and the inquiry protocol—which serve as the foundation for their work as science mentors. They begin preliminary investigations of heat transfer, specifically conduction and convection, and the underlying pedagogy of inquiry.

Outcomes

- Link mentoring to the professionalism of teaching.
- Build a community of mentor teachers.
- Understand the role of a science mentor teacher.
- Develop a vision of high-quality science teaching.
- Become familiar with the inquiry protocol as a planning and observation tool.
- Identify phases of inquiry in classroom practice.
- Experience the exploratory phase of inquiry.

Session Snapshot

Agenda

1¼ hours	<p>Welcome and Orientation</p> <p>Building a Community of Mentors</p> <p>Introducing the Parking Lot</p> <p>Putting Mentoring Into a Broader Context</p> <p>Establishing Norms</p>
2½ hours	<p>Science</p> <p>Activity 1: The Inquiry Learning Cycle</p> <p>Activity 2: Introduction to the Exploratory Phase</p> <p>Activity 3: Investigation and Data Collection</p> <p>Activity 4: Classroom Connections and Science Pedagogy</p>
2¼ hours	<p>Mentoring</p> <p>Activity 1: Qualities and Characteristics of Good Science Teaching</p> <p>Activity 2: Introduction to Inquiry Protocol</p> <p>Activity 3: Introduction to the Exploratory Phase of Inquiry in the Classroom</p>
30 minutes	<p>Reflection and Next Steps</p> <p>Reflective Journal</p> <p>For Next Time</p> <p>Evaluation</p>

How to Prepare for Session 1

What You Need to Do

- Read all introductory and background information with a particular focus on the purpose and use of the inquiry protocol (see Activity 2: Introduction to Inquiry Protocol).
- Scan through the session and review all of the directions and sidebar notes. These include activity descriptions and directions, the science background sections, the training tips, and the discussion points.
- Do the activities, if you haven't done them before as a participant.

What You Need to Make

- Make a sign-in sheet, name tags.
- Make a transparency of the Agenda or write the session's Agenda on chart paper: Hang the Agenda on a wall where participants can see it and you can refer to it throughout the day.
- Write the session's Outcomes on chart paper, and hang the paper on the wall.
- Make all of the overheads.

- Duplicate all of the handouts.
- Prepare the Norms and Parking Lot charts.
- Make a transparency of the science challenge. “Participants investigate ice cubes melting in containers of different materials and sizes to see how these factors influence melting rate.”
- Duplicate the article, “Teaching for Conceptual Change: Confronting Children’s Experience,” by Bruce Watson and Richard Konicek.
- Make the following headings on four pieces of chart paper: Exploratory, Investigation and Data Collection, Sense Making, Infrastructure.

What You Need to Acquire

- Chart paper and markers
- Sticky notes
- Spiral-bound notebook with lined paper and a divider (1 per participant)
- Overhead slide projector
- DVD player and television or a computer and video projector with a DVD player

Science Equipment for Activity 1 (per group)

- 2 paper containers (8 oz. and 32 oz.) with lids
- 3 plastic containers (1 oz., 8 oz., and 32 oz.) with lids
- 2 wide-mouth glass containers (16 oz. and 32 oz.) with lids
- Metal containers (1 coffee can with plastic lid and 1 tuna can with foil for cover)
- Paper plate
- Newspaper
- 15 mini ice cubes and a cooler to keep them in
- Stopwatch

Science Equipment for Activity 2

- Chart paper with findings from Activity 1
- Chart paper with description of activity (see below)
- Data-table chart (created by participants during the activity)
- 1 composition notebooks with divider per participant (from Activity 1)
- Data table: prepared chart for groups to record their data
- Journal Prompts overhead

Science Materials

- Each table group (3 participants per group) needs a set of plates of different sizes and materials, (1 large and 1 small): paper, plastic, aluminum foil, glass (Pyrex plate, custard cup)
- Aluminum foil (1 square foot per group)
- Paper plate for the ice cubes (1 per group)

- Newspaper
- 20 mini ice cubes per table or enough mini ice cubes so that each group has 4–6 ice cubes
- Stopwatch (1 per group)
- Chart paper and markers (1 per group)

Media List

Overheads

- 1 Not a Profession Versus a Profession
- 2 Venn Diagram—Making Sense of Science
- 3 Science Notebook Prompts
- 4 Inquiry Learning Cycle
- 5 Inquiry Protocol: Exploratory Phase and Infrastructure
- 6 Journal Prompts

Handouts

- 1 Article: “Teaching for Conceptual Change: Confronting Children’s Experience” by Bruce Watson and Richard Konicek
- 2 Article-Reading Discussion Prompts
- 3 Inquiry Learning Cycle
- 4 Inquiry Protocol, Exploratory Phase and Infrastructure
- 5 Viewing Tool—DVD Note-Taking Form
- 6 Journal Prompts

DVD

Ice Cream Making: Brenda—Classroom Observation

Welcome and Orientation (1¼ hours)

Building a Community of Mentors (30 minutes)

Overview

Because this is the first in a series of sessions, spending time initially on building a community and learning about the mentors in the group is worthwhile. If time is limited, you can carry out this activity in table groups. The purpose of this activity is to help participants introduce themselves by selecting self-definition criteria. Inform participants that you will be operating in an open, collegial way that fosters discussion and challenges assumptions.

Before Beginning

Materials: chart paper, marker, sticky notes

Training Tip

People define themselves in different ways. These can include birthplace, religion, personal or professional interests, family, ethnicity, occupation, and life experiences. Offer a few ways that people define themselves and brainstorm these and others with the group.

Steps

- 1 Have participants offer their suggestions for ways people define themselves and record these on chart paper.
- 2 Ask participants to look at the list and choose four for themselves, as a way of introducing themselves and to offer, along with that, what they'd most like to get out of the sessions.
- 3 Record what they'd like to learn on chart paper.

Discussion Points

Communicate your understanding that participants might be taking this course of instruction for a variety of reasons, such as

- The principal asked me, or
- I have been mentoring informally and wanted some training.

Some may already be involved in mentoring, while others are just thinking about mentoring as something interesting to do later. Some may find themselves far advanced in some topics and some ahead in others. Diversity of backgrounds and goals can help make for an interesting group experience.

Introducing the Parking Lot (5 minutes)

Overview

The Parking Lot—a piece of chart paper on which participants record their questions, concerns, and feedback—is one of your most valuable facilitation tools. You can use the Parking Lot to take the pulse of participants and to gauge the effectiveness of each training session. One caveat: It is very important to monitor and respond to participants' Parking Lot comments frequently. When you do so, you create an

environment in which participants feel heard and respected as valued members of a learning community.

Before Beginning

Materials: Parking Lot chart; sticky notes on tables.

Steps

- 1 Introduce the Parking Lot chart that you posted on the wall.
- 2 Ask participants to use the sticky notes on the tables to write any questions that come to mind or to jot feedback on the Parking Lot paper throughout the day.
- 3 Tell them that you value their questions and feedback and will check the Parking Lot throughout the day to be as responsive as possible.

Putting Mentoring Into a Broader Context (20 minutes)

Overview

In this section, your objective is to put mentoring into the broader context of teacher professionalization.

Before Beginning

Materials: Overheads 1, 2.

Discussion Points

Use the following discussion points as you explore the topic of mentoring:

1. Classroom teachers are isolated, and mentoring can help create a supportive culture built on collaboration.
2. Mentoring programs can help develop a norm of collaboration in a professional community.
3. Mentoring is an opportunity for well-prepared mentors to pass along years of accumulated wisdom, and to find ways to organize that wisdom and to articulate it in practical ways.
4. Working with a mentee is a responsibility to teach another person and a chance to exercise leadership as teachers carve out new roles and make important decisions that will affect future generations of science teachers.
5. Mentoring provides an opportunity to learn from, and with, a less-experienced teacher.

Steps

- 1 Show Overhead 1.
- 2 Discuss how mentoring helps overcome one of the most pernicious cultural aspects of current teaching practice— isolation.
- 3 Show Overhead 2.

Establishing Norms (20 minutes)

Overview

It is more likely that groups will support work group norms if they are part of developing the norms. So, the time you spend on this activity is an important investment in establishing a supportive, trustful, and collaborative culture in which sometimes-difficult conversations can take place. Some norms will probably include the following: prompt starting and ending times, respectful listening, confidentiality, giving space and time to quieter voices, pausing before responding, not interrupting, and supporting open and honest discussions.

Before Beginning

Materials: chart paper and marker

Steps

- 1 Brainstorm norms for successful group work.
- 2 Ask participants to suggest how the group might ensure that it meets these norms.
- 3 After the session, organize the norms, write them on chart paper, and post them at every session.

Science (2½ hours)

An Extended Investigation on Heat and Heat Transfer

Source: *Ice Cream Making and Cake Baking* (Zubrowski 1994)

Overview

In the next four sessions, participants engage in investigations from a physical science unit entitled *Ice Cream Making and Cake Baking*. They investigate how ice cubes melt in different kinds of containers and on different kinds of surfaces. They collect data on the cooling rate of hot water in different kinds of containers

surrounded by three different water environments. Finally, they use this data to decide in which container to make ice cream and the best cooling environment in which to freeze it. Through the context of this unit, participants experience the phases of the inquiry learning cycle—exploration, investigation and data collection, and sense making. Participants can consider how they do or can incorporate each of these phases into their own teaching.

Activity 1: The Inquiry Learning Cycle (20 minutes)

Before Beginning

Materials: Overhead 4

Steps

- 1 Introduce participants to the inquiry learning cycle (see Figure 1).
- 2 Discuss each of the phases and ensure that participants understand each of them.
- 3 Ask participants to give an example of each of the phases from a lesson they have taught.

Figure 1: Inquiry Learning Cycle	
<p>Exploration</p> <ul style="list-style-type: none"> • Teacher introduces the inquiry • Students get acquainted with a problem or phenomenon and decide what kind of experiment they will set up <p>Investigation and Data Collection</p> <ul style="list-style-type: none"> • Students carry out experiments and make measurements and/or observations • Students collect data on their experiments • Students report their measurements or observations <p>Sense Making</p> <ul style="list-style-type: none"> • Teacher and students analyze the usefulness and meaning of the data • Teacher and students develop explanations and conceptualizations 	<p>Infrastructure and assessment elements are present throughout the whole cycle.</p> <p>Infrastructure</p> <ul style="list-style-type: none"> • Teacher decides how to manage materials • Teacher decides when and how students will work with other students • Teacher develops routines and procedures <p>Assessment</p> <ul style="list-style-type: none"> • Teacher determines what students will need to know and be able to do • Teacher decides how and when he or she will assess students

Points to Address

The first few lessons in this unit are explorations.

1. Because the parts of the cycle are inherent in all of the phases, participants also collect data and make some interpretations.
2. As the unit progresses, lessons focus more on one phase, but once again aspects of the other phases are present.
3. In this first session, participants will work with a variety of containers and plates made of different materials.
4. Their task is to gather some initial data about the effect of these containers on the melting rate of ice cubes.

Activity 2: Introduction to the Exploratory Phase (40 minutes)

Overview

Participants investigate ice cubes melting in containers of different materials and sizes to see how these factors influence melting rate.

Science Background

The warm air of the room contacts the ice cubes and causes them to melt. The heat in the air is conducted through the material of the container as well. The density of a material contributes to its thermal conductivity. Low-density materials, such as air, have the poorest thermal conductivity. Dense metals conduct heat better than light metals. The heat capacity of the container is also a factor. The *heat capacity* is the ability of an object to hold heat. Some materials hold heat better than others at any given temperature.

Before Beginning

- Write the activity on chart paper and post the chart paper.
- Before beginning this section of the day, place all materials on the tables, except the ice cubes; leave these in the cooler until you have finished giving directions.
- Divide participants into groups of three for this activity.

Steps

- 1 Focus participants on the steps of this exploration.
- 2 Point out that on participants' tables are containers of different sizes and materials. They will examine the containers' effect on the melting rate of ice cubes.
- 3 Begin by asking participants to discuss and then predict which containers allow ice cubes to melt most quickly and most slowly. Have participants record their predictions and the reasons for their predictions in their science notebooks. Once they are finished, begin the exploration.
- 4 Distribute at least 15 mini ice cubes on a paper plate to each group.
- 5 Allow about a half an hour for this exploration. During the exploration, spend time interacting with each group. Make sure that participants record all of their data by asking them questions such as
 - What are you noticing?
 - Why do think this is happening?
 - Are there differences among containers?
 - Does anything that is happening surprise you?
- 6 Listen to participants' comments and jot them down. The purpose here is twofold: This knowledge helps focus the kinds of questions you ask in the follow-up discussion and elicits the kinds of student science discourse that occurs during exploratory activities. As the exploration nears the end, remind participants to observe closely, because the pieces of ice are transparent and participants might not be able to see them easily, even when the cubes have not yet completely melted.

Training Tip

While the groups are working, prepare a data table for the groups to use to record their data. The table should list each container used in the exploration and have a column for each group to record its melting times.

This is an example:

	Group	1	2	3	4
Container					
Metal (coffee)					
Metal (tuna can)					
Plastic (1 oz.)					
Glass (16 oz.)					
Paper (8 oz.)					

Discussion

During the exploration, participants collected data about melting ice cubes. This discussion will help you and the participants determine what and how they are thinking about melting and the factors that contribute to melting.

Steps

- 1 As each group finishes the exploration, remind participants to put their group's data on the data table.
- 2 Once every group has recorded its data, ask each group to report their findings relevant to their observations.
- 3 Facilitate a group discussion about conclusions participants might make based on the data. Do not correct participants' thinking or give them the right answers. It is not important that participants' thinking is totally accurate at this point. Remember that this is the exploratory phase of inquiry, in which participants access their prior knowledge and become familiar with the materials and how they interact.
- 4 Ask participants the following questions:
 - What are some preliminary explanations for the results?
 - What effect does the material of the container have on the melt time?
 - How does the data compare to their predictions?
 - What surprised you about this experiment?
 - What data does not fit and how do you explain this?
- 5 Record participants' thinking on chart paper and post the paper. Participants may suggest that a metal container will allow the ice cube to melt more quickly because it is a better conductor of heat. Questions about size of the container as a variable may arise.
- 6 Ask participants the following questions:
 - What science concepts did you investigate in this exploration?
 - In which direction do you think the heat is moving? Is heat going into the ice cube or is cold going into the container? (Participants will most likely say that the cold is going into the container.)
 - What is the evidence?
- 7 Record participants' thinking on chart paper and post the paper.

Training Tip

At this point give participants a 15-minute break.

Activity 3: Investigation and Data Collection (60 minutes)**Overview**

This activity moves participants more formally into the investigation and data collection phase. In this phase, participants carry out measurements or observations and report them. In this second investigation, participants experiment with plates made of different kinds of materials and different sizes plus the small ice cubes. They discuss and make predictions about relative melting rates of ice cubes on the different plates. During the second part, they design experiments that identify the variables that affect melting rate.

Before Beginning

- Make sure that the data table from the previous activity is still posted.
- Post chart paper with the next exploration: Do ice cubes melt faster on paper, plastic, glass, or metal?
- Place all materials on the tables, except the ice cubes; leave these in the cooler until you have finished giving directions.
- Plan to divide participants into groups of three for this activity.

Science Background

This exploration continues to develop ideas about the relationship between properties of different materials and conduction, but it introduces new variables. Participants now consider the effect, if any, the shapes and amounts of the materials have on melt time.

Steps

- 1 As with any beginning investigation, participants begin by discussing and making predictions about the relative melting rates of ice cubes on plates of different materials and sizes.
- 2 Refer participants to the chart paper with the investigation: “Do ice cubes melt faster on paper, plastic, glass, or metal?”
- 3 Have participants review the findings from the first activity, referring to the data table from the previous activity.
- 4 Ask them what information from the data table is relevant for this challenge.
- 5 Be sure to have them make a prediction.
- 6 Have participants record their predictions and the reasons for their predictions in their science notebooks.

- 7 Point out that a variety of plates of different sizes and materials are on participants' tables. They will use these plates to continue to explore the effect of different materials on the melting rate of ice cubes.
- 8 Remind participants that, during this investigation and data collection phase, they should take careful notes of their observations in the first section of their science notebooks so they can share their data after they've completed the exploration. Groups will transfer their data onto the chart paper so all participants can compare the findings among the groups.
- 9 Tell groups to experiment with the different plates to try to determine the effect of their material and size on the melting rate of the ice cube. Allow about 20 minutes for this activity.

Training Tip

During the exploration, spend time interacting with each group by asking the following questions:

- **What are you noticing?**
- **How might you organize the data?**

Discussion

This discussion will help participants make sense of their findings.

Steps

- 1 When participants have completed the experiment, tell each group to rank the melting times.
- 2 Collect each group's results, post them on chart paper, and save them for the next session.
- 3 Ask the following questions:
 - How do these results correlate with the previous activity?
 - What are some tentative explanations?

Activity 4: Classroom Connections and Science Pedagogy (30 minutes)

Overview

This section helps participants connect their work to their classrooms. Here they think about how they begin or open a learning experience for their students. They consider similarities to and differences from what they experienced in the science investigation.

Before Beginning

Materials: Overhead 3. Make sure that participants have their science notebooks.

Steps

- 1 Tell participants they will now have an opportunity to write in the second part of their science notebooks and call it “Classroom Connections and Science Pedagogy” (see science notebook description in the “The Program in Detail,” under Program Components,” p. XXX).
- 2 Put Overhead 3 on the overhead projector.
- 3 Ask participants to answer the following questions in their journal. They will have 10 minutes to complete the journal.
 - How do you introduce a unit, investigation, or activity in your own classroom?
 - How is this similar to and different from the way this investigation was introduced?
- 4 Use the remaining 20 minutes of this segment to hold a whole-group discussion to elicit participants’ ideas and strategies.

Mentoring (2¼ hours)

In the last part of this session, you will focus on mentoring. Participants will reflect upon their notion of standards-based, inquiry teaching so they can begin to establish a consistent vision among the group members.

Activity 1: Qualities and Characteristics of Good Science Teaching (45 minutes)**Overview**

We designed this activity to help participants envision what good inquiry science teaching looks and sounds like in a classroom. It is important for mentors to examine the principles behind inquiry science before they begin their mentoring work.

Before Beginning

Materials: Sticky notes, 4 pieces of chart paper with each of the phases of inquiry—*exploration*, *investigation and data collection*, and *sense making*—and *infrastructure* written on each sheet.

Steps

- 1 Initiate a general discussion explaining that it is important for teachers to have a vision of those qualities and characteristics that make for good science teaching.
- 2 Ask participants to think of an excellent science teacher who provides the kind of instruction that promotes increased student science achievement for all students.
- 3 Ask the following two questions:
 - What specific qualities does this teacher bring to her or his teaching?
 - What are the characteristics and instructional approaches of the science teachers whom we are proud to have as colleagues?

- 4 After a brief explanation, ask participants to write one quality each on a separate sticky note.
- 5 Suggest participants think about the science activity they just experienced.
- 6 Ask participants to think of some of a good teacher's characteristics they have noticed.
- 7 Encourage participants to write down at least five characteristics.
- 8 Point to the chart paper and introduce the three phases of inquiry and infrastructure.
- 9 Explain that you are going to put their ideas of good teaching in the context of a larger conversation that has been going on around the country about the standards-based inquiry approach to teaching science. Participants will decide where to place their sticky notes—under which inquiry phase or infrastructure element each of their qualities fits.
- 10 Have participants, group by group, come up to the charts and affix their notes. Some qualities may belong on more than one chart, but encourage participants not to be too worried about placing their sticky notes correctly. The point of the exercise is to create visions of what inquiry science teaching and learning looks like. If they can't decide where to put a note, tell them to place it on the side of a chart and the group can decide where it belongs.

Training Tip

After all the sticky notes are on the charts, have participants look at the chart paper and write down their thoughts about any sticky notes whose position they question. Facilitate a conversation about any questions that participants raise. Highlight some sticky notes that reinforce the phases of inquiry. Explain that these phases are based on the inquiry standards they will study in a subsequent session. This is a starting point for having participants think about inquiry phases and standards. Be sure to take time to explain the concept of infrastructure and what kinds of rules, routines, and procedures need to be in place for teachers to be able to engage in inquiry science in classrooms.

After the session is over, type up the sticky note comments on each chart to use in Session 5. You will use this activity as a reference point for the discussion during that session. Help participants understand that these phases are based on national standards, that they are part of a national conversation about what constitutes best practice, and that there is curriculum existing, with these standards serving as a framework, that will also address state standards.

Activity 2: Introduction to Inquiry Protocol (30 minutes)*Overview*

During the science section, participants learned about the phases of the inquiry learning cycle. This activity will introduce them to the inquiry protocol. The inquiry protocol delineates classroom activities and behaviors that occur during each phase of inquiry. The focus here is on the exploratory phase.

Before Beginning

Materials: Chart paper, Handout 3

Steps

- 1 Explain that today the focus is on the exploratory phase of the inquiry protocol.
- 2 Participants will work with a partner to unpack the specifics of that phase and to gain a clearer understanding of it.
- 3 Ask participants to select a partner and, with that partner, look carefully at the components of the exploratory phase and the infrastructure component to prepare for the next activity.
- 4 Encourage mentors to talk about specific examples of what this might look like in the classroom.
- 5 Ask partners to highlight elements that are either new or challenging to them.
- 6 Distribute Handout 3.
- 7 Close by asking partners to share their insights and what they learned.

Activity 3: Introduction to the Exploratory Phase of Inquiry in the Classroom (1 hour)*Overview*

During this section, participants look at a science classroom during the exploratory phase of an inquiry project and learn more about how this phase of inquiry looks in practice. Provide the following background information:

- This 28-minute clip was filmed in Brenda Busta’s classroom in Lowell, Massachusetts. The introduction is 6:30 minutes; the group work is just under 12 minutes; the wrap-up and sense making is 9 minutes.)
- This is the introduction to the ice cream–making unit, which focuses on the science concepts of heat transfer and properties of different materials.

Before Beginning

Materials: DVD, DVD player and TV, Handouts 4 and 5, Overhead 5.

Steps

- 1 Prepare the environment for participants by explaining that it is important to bring a spirit of curiosity about teaching and learning to the task of watching this DVD.
- 2 Instruct participants to view the video assuming that the teacher whose class they are observing is watching the video with them. The purpose of watching the clips is to examine the exploratory phase of the inquiry protocol in practice.
- 3 Ask participants to consider the following question: What instructional strategies does the teacher use and what infrastructure is already in place prior to this lesson? Even if they might have taught the lesson differently, suggest they ask themselves what the teacher was trying to do and how she was addressing the exploratory phase of inquiry.
- 4 Divide the group into two. Ask Group A to watch the DVD and focus on finding evidence of the exploratory phase. Instruct Group B to look for infrastructure.
- 5 Distribute Handouts 4 and 5. Use the note-taking Handout 5 as a guide for observation.
- 6 Use Overhead 6 to clarify the elements of the exploratory phase and infrastructure.
- 7 Use the ice cube science lesson to give specific examples.

Reflection and Next Steps (30 minutes)

Reflective Journal (15 minutes)

Overview

In this session, and in others to come, you give participants time for reflective writing and conversation—areas of professional practice too rarely offered to teachers. Following activities, participants share some of their reflective writing and discuss areas and topics that stimulated new thoughts and ideas. This session began with a discussion of the professionalism of teaching. This journal segment now provides you with an opportunity to bring the session back to that topic. Because reflective journals are powerful tools for teachers to focus on their concerns and track their professional growth, they can provide a vehicle for thinking critically about classroom practice. In this exercise, you position the reflective journal as a device for assessing progress, summarizing knowledge, and providing direction for the next steps in the process of becoming a science mentor.

Steps

- 1 Distribute Handout 6 and put up Overhead 6 (Journal Prompts).
- 2 Ask participants to direct their thoughts toward the following questions:
 - Why am I interested in science mentoring and what's in it for me?
 - What qualities and skills do I bring?
 - What skills do I need to develop so I can work more effectively with my colleagues?
 - How might I introduce the investigation if I used this ice cream-making unit in my classroom?
 - What infrastructure would I need to have in place before I could begin an exploration?
- 3 At the end of the day, before participants leave, we strongly recommend that you collect the journals, make copies, and return the journals to participants. In this way you will be able to keep a pulse on the needs of the group.

For Next Time (5 minutes)

Steps

- 1 Give participants Handout 1, the article "Teaching for Conceptual Change: Confronting Children's Experience" by Bruce Watson and Richard Konicek, and Handout 2. Ask them to read the article and to write in the Classroom Connections section of their science notebook their ideas about the following questions:
 - How did the teacher begin her unit on heat?
 - How did the teacher use what she learned about her students' prior knowledge about heat?
 - What concepts about heat was the teacher trying to develop?
 - What might the teacher have done differently?
 - What are the implications of everyday language for the development of students' science conceptual understanding?
- 2 Ask participants to prepare to discuss the article at the next session.

Evaluation (10 minutes)

Overview

This activity is an important source of information for you as you prepare to facilitate future sessions.

Steps

- 1 Ask participants to write "Highlights" on one side of a page of their journals and "Wishes" on the other side.

- 
- 2 Ask participants to write on the highlights side about what they enjoyed and found beneficial about the work of the day.
 - 3 Ask participants to write on the wishes side about things they wish had happened today or they hope will happen in the future.
 - 4 Ask participants to give you their journals. Make copies of their entries, and return their journals to them. Also, encourage participants to stick their sticky notes with questions or concerns on the Parking Lot as they leave.

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