Preface

Improving Student Achievement Through Professional Development: A Rationale for Professional Development in Science

Teachers are working harder than they ever have to manage classrooms, address issues of diversity, and deliver high quality instruction, and, yet, student achievement on national assessments falls short of the high expectations we have for our nation's schools. Teacher education programs at the undergraduate level strive to provide preservice teachers with the knowledge and skills they will need to offer high quality instruction as classroom teachers. But, beginning teachers often face challenges for which they were not prepared, and the important messages from their education and methods courses are repressed as they struggle to meet the demands of the job.

Well-designed professional development initiatives can address critical needs related to standards and accountability. Quality professional development programs build on the basic foundations established in teacher education programs and take teachers to the next level of content knowledge, skill development, and confidence that empowers them to teach more effectively. The goals of high quality professional development must link closely to districtwide school improvement goals and science reform focused on increasing student achievement. Carefully crafted and managed professional development programs provide a collective focus on the vision and goals of the school system and offer multiple pathways for increasing knowledge and developing skills that lead to more effective teaching.

A recent study points to the state of the art in science and mathematics education in the nation's classrooms. In *Looking Inside the Classroom:*

A Study of K-12 Mathematics and Science Education in the United States (Weiss et al., 2003), researchers observed over 350 mathematics and science lessons and rated them on lesson design, lesson implementation, content addressed, and classroom culture. Assessment levels were assigned ranging from Level 1: ineffective instruction (passive learning and activity for activity's sake) to Level 5: exemplary instruction. Based on the observer's judgments, only 15% of the lessons were considered to be high in quality, 27% were rated medium in quality, and 59% were considered low in quality. Findings at the middle school level were even more staggering. Only 7% of the science lessons were rated high, while 78% of science lessons were rated low. Such findings send a message of importance about what teachers teach and, more important, how teachers teach.

Given that both content and methods are linked to student achievement, professional development programs must target goals to improve both the knowledge base of teachers and the skills of their discipline. Confidence and efficacy are needed to develop and maintain learning-centered environments.

References to *How People Learn* (National Research Council, 2000) and other research-based reports are made throughout this book in support of inquiry. Principles related to brain-based learning, transfer of learning, the development of thinking and problem-solving skills, and meaningful learning in general, are addressed through inquiry-based instruction. Inquiry is the process through which scientists and other professionals learn; as such, it is a powerful approach to classroom learning. This book is offered as a practical, much needed first step to addressing standards in an atmosphere of active, inquiry-based learning.

> It is not enough to do your best
>
> You must know what to do and then do your best
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> —W. E. Deming

THE GOALS OF EIGHT ESSENTIALS

The Eight Essentials are designed to promote a clear, structured awareness of the ways a carefully designed inquiry-based science program can engage learners; explore natural phenomena to create a greater awareness and deeper understanding of the basic concepts and principles of science; use and develop reading, writing, and thinking skills; provide opportunities

for students to reflect on and discuss experiences, frame thought and meaning through making connections and elaboration, and extend learning by developing new questions that promote further, and more open inquiry.

The Eight Essentials offer a set of criteria against which instructional materials can be assessed and modified and show a variety of ways that instructional materials can address these criteria. *Eight Essentials of Inquiry-Based Science, K-8* is not a methods book, but, rather, one that focuses on inquiry-based instruction as a powerful approach to teaching key concepts and skills of science while addressing other valued learning goals. Instructional materials designed around the Eight Essentials provide teachers with an essential ingredient needed to implement high quality instruction and assessment.

Throughout this book, inquiry is shown, not as a single method, but as an approach to active learning that ranges from more structured, teacher-guided inquiry to more open, student-constructed inquiry. Many of the examples are shown in a more structured, guided discovery format to model how one might address one or more of the Essentials within an activity.

Guided inquiry questions and well-designed investigations lead the learner toward an awareness and understanding of standards-based concepts, while using and further developing process, critical thinking, and problem solving skills. A big part of the value of guided inquiry lies not only in the learning, but in the new questions that are raised throughout the learning experience. Guided inquiry also provides a teacher-friendly model of inquiry, with most samples prompting new questions and encouraging student-constructed inquiry.

USING EIGHT ESSENTIALS OF INQUIRY-BASED SCIENCE IN STUDY GROUPS AND PROFESSIONAL DEVELOPMENT INITIATIVES

The Eight Essentials offer a practical, user friendly approach to learning about the important components of science education upon which national and state standards and assessments are based. Each chapter provides important information; sample activities; questions for discussion, reflection, and meaning making; and applications that focus on the value of inquiry-based science for meaningful learning and increased student achievement.

As a professional development resource, this book was designed to lead teachers to:

- a greater understanding of the ways that teacher-guided inquiry and student-constructed inquiry can promote the learning of important goals and standards
- an increased awareness of high quality classroom instruction.

The book may be used in study groups where teachers read and study chapters on their own and come together to discuss the inquiry questions, work through the activities, and discuss classroom applications. Teachers can try new ideas and strategies by applying the Eight Essentials to their classroom instruction and discussing their experiences.

University science educators, school district science leaders, teacher leaders, school administrators, and professional development providers may use the book in more formal education programs focusing on the goals of effective teaching and learning of standards-based science.

A METACOGNITIVE APPROACH

The approach used in this book is based on a metacognitive model wherein professional development or study group participants:

- are introduced to new ideas related to inquiry
- discuss information, models, graphics, and experiences; ask questions
- interact with one another to strengthen knowledge and skills related to concepts and principles of effective teaching and learning
- extend their learning through guided or open inquiry investigations and research, as needed
- apply new learning and research-based best practices for improving student achievement
- assess the effectiveness of their instruction

This model can be replicated with students.

THE I.D.E.A. APPROACH

I Introduce

D Discuss

E Elaborate and Extend

A Apply and Assess

Introduce

Each chapter begins with an inquiry question related to the topic, which is followed by information or experiences in the form of standards, concepts, research findings, questionnaires, inventories, best practices, and activities that relate to effective teaching and learning in science. Inquiry questions are revisited to summarize learning.

Discuss

Questions that elicit thought and reflection about the topic are discussed. Through the discussion process, understandings and misconceptions are identified, beliefs and practices are challenged, action plans for learning or applying new ideas are suggested, and new questions are generated. Discussion is an important part of the process of building a greater understanding of science education and of developing confidence in the ability to teach inquiry-based science effectively.

Elaborate and Extend

Following discussion and reflection, learners may find it helpful to engage in additional activities or laboratory experiences, conduct library or Internet research, participate in field experiences, or survey or consult human and other local or state resources to elaborate on topics, answer questions, and extend or enhance learning prior to making applications to their classrooms. Here teachers may experience an "open inquiry" approach to learning by designing action plans to answer questions.

Apply and Assess

In addition to reflecting on current practices and learning new concepts and strategies, readers are encouraged to apply new learning and research-based best practices to their classroom teaching. Continuous reflection and assessment of the applications is critical for the development of new models of effective practice for future use. The form shown in Figure I.1 can be used to facilitate this reflection and assessment.

Essential #1: Inquiry-Based Science Develops an Understanding of Basic Concepts

Essential #2: Inquiry-Based Science Develops Process and Thinking Skills

Essential #3: Inquiry-Based Science Actively Engages Students in a Learning Cycle