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Foreword

This is an impressive book. If you are a high school science teacher, Lee Shumow and Jennifer Schmidt have written this book for you. One of the greatest challenges you face as a teacher is how to motivate *all* of your students—girls and boys—to learn science. In this book, Shumow and Schmidt help you to meet this challenge by sharing with you advances in motivation theory, research, and exemplary practices. They give particular attention to the role of gender. Their research on how best to motivate high school students to learn science has been supported by grants from the National Science Foundation.

Science motivation is important because it fuels *scientific literacy*, which is the understanding of scientific concepts and processes required for making personal decisions, participating in societal affairs, and contributing to economic productivity. Scientific literacy benefits your students who aspire to be future scientists. But, just as importantly, scientific literacy benefits *all* of your students, because science plays an important role in careers of all kinds.

You will find this to be a highly readable book. It is clearly written, free from jargon, conversational in style, and very engaging. In general, the authors take an evidence-based approach to the recommendations they make about how you can motivate your students to learn science. This book is organized into ten chapters, and each one is a gem. Each chapter focuses on a key concept that has been recognized in contemporary national science standards as important in increasing students' motivation. Each chapter begins with an engaging vignette—based on the actual experiences of high school teachers—that illustrates the key concept, provides a rationale for its importance, describes the research that supports it,

and offers advice on how best to apply it. The chapters describe and illustrate proven motivational strategies that are designed to foster high achievement in both girls and boys. The strategies are based on a sophisticated understanding of variations in the attitudes, beliefs, and backgrounds of girls and boys learning science.

Throughout this book, Shumow and Schmidt write with a deep understanding of the challenges that you face as a high school science teacher. These challenges are many, such as large class size, limited instructional resources, and students who vary considerably in their preparation and backgrounds. This state-of-the-art book will help both new and seasoned teachers to meet these challenges. This book, written by two nationally recognized experts in educational research, will help science teachers foster students' motivation and scientific literacy.

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Series Preface to *Classroom Insights*

Division 15, Educational Psychology, of the American Psychological Association and Corwin partnered to create the *Classroom Insights from Educational Psychology* series for teachers in an effort to reduce the widening gap between research and theory on learning, teaching, and classroom practice. Educational psychology is a discipline that seeks to understand the integration among human development and learning, classroom learning environments and instructional strategies, and student learning and assessment. In this way, the field of educational psychology is among the most relevant and applicable for teachers.

While we have seen great advances in our understanding of student learning and instructional practices over the last decade, these advances are not highly visible in today's classrooms, pre-service and graduate teacher education programs, or professional development for teachers. Consequently, classroom practice, for the most part, does not seem to be highly influenced by current research and theory in educational psychology. Yet there are international calls for scientifically based practices, research-based methods, or evidence-based decisions in our schools. As part of the solution to this problem, this series of short, easily accessible books for teachers is designed to synthesize in-depth, high-quality research, to be used in a variety of educational settings, and is endorsed by Division 15.

As the *Classroom Insights* series evolves from its first volumes under founding editor, Dr. Barbara McCombs, we as editors continue to work with teachers and researchers to identify the topics that are most relevant to educators. We are guided by research that honors the highest-quality learning environments with practices proven to support all students, help them succeed in their schooling, and sustain their love of learning. The goals of this series are threefold:

- To give practicing and preservice teachers access to current advances in research and theory on classroom teaching and learning in an easily understood and usable form
- To align educator preparation, graduate study, and professional development with current advances in research and theory, which have not been widely shared with teachers
- To highlight how the most effective teaching practices are based upon a substantial research base and created within classrooms, rather than applied in a “one-size-fits-all” or “silver bullet” approach across classrooms

Classroom Insights provides a series of specialized books to inform teaching and learning in Pre-K–12 classrooms by focusing on what is most important and relevant to today’s teachers. In some volumes, the applications are limited to specific age levels or characteristics of students, while in most volumes, the ideas can be broadly applied across Pre-K–12 settings. Classroom strategies are integrated throughout every book, and each includes a wide array of resources for teachers to use to study their practices and improve student achievement and classroom learning environments. Finally, many of these research-based applications will be new approaches and frameworks that have never been published in a series for teachers.

As series editors, our goal is to provide the most up-to-date professional series of teacher resources for connecting teachers with the highest quality and most relevant research in our field of educational psychology. We have planned for every page to provide useful insights for teachers into their current practices in

ways that will help them transform classroom learning for their students, themselves, and their school communities.

Sincerely, Your Series Editors



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Preface

“My students just aren’t motivated to learn science.”

How many times have you thought or said this? If you are like most science teachers we have spoken with, your answer is “often.” Motivating high school students to learn is a primary concern of educators today and a challenge that many science teachers face daily in their classrooms. While it is certainly frustrating to have students who are apathetic toward learning, the good news is that teachers can have a significant impact on the way students approach learning tasks. Put simply, student motivation is something that you can influence. The purpose of this book is to help you learn more about how you can accomplish this. The primary title we have chosen for this book reflects the ultimate goal: *Enhancing Adolescents’ Motivation for Science*. In the two years that we have spent researching and writing this book and developing its companion materials, we have come to refer to this whole endeavor using the acronym for “empowering teachers to enhance adolescents’ motivation for science”, the E-TEAMS Project.

In order to teach effectively, science teachers must integrate knowledge about science content, instructional methods, and student learning, motivation, and development (Davis, Petish, & Smithey, 2006). In a recent study, high school science teachers agreed with the teachers we interviewed, saying they knew little about how to motivate their students. This is especially troubling, because the research shows that when teachers know more about motivation, their students are actually more motivated and more academically successful in science (Hardre & Sullivan, 2009).

Gender is often an important factor in motivation for learning science. As a science teacher, you are likely aware that there have

historically been gender gaps with respect to students' attitudes, achievement, and persistence in science. Because of these differences, many of which still exist today, the tools that are most effective at enhancing boys' motivation for science are sometimes (though not always) different than those that work best to boost girls' motivation. It is only logical after all, that if boys and girls have different experiences, attitudes, or expectations about science, the kinds of factors that would motivate them to engage in science should differ somewhat as well. We highlight gender differences throughout the book when research suggests that special attention to student gender is warranted.

Although there are many resources for teachers on fostering student motivation in general, our search did not reveal any books written specifically for science teachers or science teacher educators. It seemed important, then, to provide such a book together with companion materials targeted specifically for the high school science educator to address the unique motivational challenges their students present. Science teachers at other grade levels can glean helpful information from this book as well.

This book has been written for aspiring science teachers, practicing science teachers, and science teacher educators to help you learn more about motivating both male and female high school students to learn science. Each chapter and its supporting materials aim to enhance your understanding of motivational constructs that operate in science classrooms by

- describing and demonstrating useful motivational strategies in science classrooms,
- promoting your understanding of the student perspective on high school science classes,
- sensitizing you to possible gender differences in student motivation and perspective, and
- describing how you can make classroom experiences in science more equitable.

Ultimately, your knowledge about student motivation and how to enhance it in practice can positively influence your students' motivation for science. In the process, you can help increase your students' interest and persistence in fields related to science, technology, engineering, and mathematics (STEM) and narrow gender gaps in students' motivation to pursue science at a higher level.

All of these end-states are consistent with the goals outlined in the Next Generation Science Standards (NGSS), which were being finalized and implemented when this book was published. While we believe the material in this book transcends any set of content standards, the tools provided in this book can be used to support the NGSS by facilitating the progression of knowledge in order to prepare students for deeper levels of science investigation over time. The focus on gender also supports NGSS, as females are a traditionally underrepresented group in most science fields.

This book can be used independently, as part of a professional learning community (PLC), or as a text in a formal science education class. We expect that most teachers reading this book will be interested in achieving most or all of the aforementioned goals, and the book can certainly be read in its entirety in this pursuit. However, busy teachers might not have the time to read, retain, and apply all of the content at once. Therefore, we tried to design each chapter to stand alone in such a way that readers could pick it up, look up a specific aspect of motivation, learn about it, and use its resources without having read prior chapters. The book and its accompanying resources, described below, were designed to allow you to consult and use the materials selectively to meet your needs as they arise in the classroom or as a supplement to other science education texts.

ENHANCING MOTIVATIONAL KNOWLEDGE AND PRACTICES

We wrote this book to provide insight into student perspectives on high school science classes, to provide background information on motivation among male and female students in those classes, and to suggest concrete ideas about how to positively impact student motivation for science.

Structure of the Book

Each chapter concentrates on a single construct that has been widely shown to influence student motivation to learn and that has been shown to be heavily influenced by teacher practices. We realize that there are many aspects of students' lives that can get in the way of their learning, and many of these things cannot be

changed by teachers. However, each chapter focuses on those things that teachers can influence, regardless of their students' personal circumstances. Chapter topics were chosen based on our observations in high school science classrooms and in consultation with high school science teachers, science teacher educators, gender scholars, and experts in motivation to learn science.

Within each chapter, we define the motivational construct under consideration and provide an illustrative explanation of how it is important to high school science teachers and students. These examples are drawn from observations we have made in our research: Some are loosely based on our observations, while others are verbatim accounts taken from video data. We briefly summarize the research related to each construct and discuss implications for motivating boys and girls in high school science. We have tried to present motivational processes in science in a way that is accessible, practical, transcendent of specific learning standards, and useful for a variety of stakeholders. Further, we aim to empower you to motivate your students with your teaching practices. We provide suggestions for evidence-based practice, drawing upon our own research and that of other experts in the field.

Companion Materials

A variety of multimedia resources supporting the book are available through our website, <http://www.niu.edu/eteams>. The site contains brief video clips of real students, teachers, and scientists demonstrating and reflecting upon the constructs described in the book or using our suggestions for practice. These video clips are linked to the book chapters, with each chapter having one or more associated video clips. The website also presents video profiles of the featured science teachers and scientists so that viewers interested in focusing their attention on a broad array of motivational topics within particular areas of specialization (e.g., AP biology or particle physics) can easily do this. Additional resource links and future reading suggestions are provided to accompany each book chapter. PowerPoint presentations are provided for intended use in science department meetings, PLCs, or science education classrooms. These presentations summarize the material in the book, have hyperlinks to the video demonstrations and other relevant material, and include optional discussion or

reflection activities for audience members. Parent education resources also are available. We provide several short newsletter articles for families of high school students, focused on enhancing their child's motivation and interest in science. Science teachers or school administrators can post these on school websites or distribute them to students' families. URLs for websites that have specific science-related activities for families appear on the companion website. All of the material on the E-TEAMS website will continue to be updated as we become aware of new resources.

OVERVIEW OF CHAPTERS

In the first chapter, we introduce the concept of motivation as it pertains to science in particular. We also describe the Science-in-the-Moment (SciMo) Project—a research study we conducted in high school classrooms. We draw upon data from the SciMo Project to illustrate many of the motivational processes we discuss throughout the book. This chapter provides a brief introduction to the methodology and primary results from the study, with more detailed methodological information provided in the appendix. Chapters 2 through 10 are focused on specific motivational constructs and processes. As you read them, you will note that they often cross-reference each other, as many of them are related. Chapter 2 focuses on the various ways students might find value in science and how teachers can promote the value and relevance of science in a way that engages and excites students. Chapter 3 deals with relationships in the classroom and discusses how teachers can create a positive classroom climate and foster positive relationships with and among their students. Chapter 4 introduces the concept of autonomy and offers suggestions about how science teachers can afford their students a sense of choice and control while still meeting learning objectives. Chapter 5 discusses multiple strategies for building students' confidence in science and illustrates the positive effects this can have on student performance and engagement. In Chapter 6, we consider student success: While we all want our students to be successful, certain types of successes are more motivating than others, and the way we interpret and explain our success (and our failures) is critical for continued motivation. This chapter

discusses what teachers can do to get the most out of their students' successes. Chapter 7 focuses on the types of goals that students have when they are doing their academic work. We discuss goals that are focused primarily on understanding compared to goals that are simply about performing well. We discuss the motivational implications of these different goal orientations and offer suggestions as to how teachers can structure their classrooms in ways that promote productive goals among their students. In Chapter 8, we discuss the different ways students think about the nature of ability. Some students view their science ability as fixed and unchangeable, while others believe their science ability can grow. These different mindsets have dramatic effects on students' motivation and achievement. Chapter 9 provides a discussion of the impact of challenge on student engagement and provides some tips for constructing science learning environments that are optimally challenging for students. Finally, in Chapter 10, we discuss the role of emotions in learning and motivation in science. We discuss the impact of both positive emotions such as enjoyment and negative emotions such as anxiety. At the end of the book, we provide an appendix, which includes a more detailed description of the methodology of the SciMo Project for those who are interested in additional information.