Look at Us Now!

Making Scientific Practices Matter in the *Classroom* *...and Beyond*

Using the Research Investigation Process RIP®

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Foreword by Robert E. Yager, PhD

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FOREWORD

More Emphasis on the How vs. the What

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It's common knowledge that we are in the midst of being challenged as a nation to compete and succeed in the arena of STEM education. In order to deliver the demands of this challenge, the development of critical thinking skills necessary as a habit of practice in every classroom, from kindergarten through high school and beyond, must be a central focus and priority in science education as well as in all other fields. This is not only imperative, but urgent. The story interwoven across the inquiries presented in *Look at Us Now! Making Scientific Practices Matter in the Classroom…and Beyond Using the Research Investigation Process* shares a single theme—teachers and their students THINKING as they learn content through scientific inquiry and scientific inquiry as content.

Too often current reform efforts start with content to be taught without attention to the acts of teaching. *Look at Us Now!* is an exciting book and the exception to the rule that focuses on how the art of teaching must be improved for the reforms to succeed.

It is interesting to note that the 1996 *National Science Education Standards* (NSES) effort began with teaching reforms as the first major section of the 203 page document to indicate changes needed (National Research Council, 1996, p. 13). But the 1996 Standards are now often referred to as the "old" Standards because they were completed 16 years ago after four years of effort and five versions shared with all. No one seemed concerned or negative with the four goals which opened the NSES. These four goals were stated as producing students who can: (1) experience the richness and excitement of knowing about and understanding the natural world; (2) use appropriate scientific processes and principles in making personal decisions; (3) engage intelligently in public discourse and debate about matters of scientific and technological concern; and (4) increase their economic productivity through the use of the knowledge, understanding, and skills of the scientifically literate person in their careers (National Research Council, 1996, p. 13).

Almost as easily the committee assigned to undertake "Reform Teaching" proposed specific changes needed in teaching! The team responsible for dealing with these changes also had an easy job in offering and gaining approval for the 1996 efforts regarding teaching. The work regarding science teaching was "applauded" with practically no disagreement and no one objected or seemed concerned with the features offered for preparation of new science teachers. There were nine "*More Emphasis*" features for reform in science teaching (National Research Council, 1996, p. 52) and all of these can be found among the various contributions in this book, *Look at Us Now!*

Without disagreement, objections, or conflicts the Teaching team also considered the needed features for reform of Professional Development efforts. These fourteen *More Emphasis* features were produced outlining standards just before release of the completed standards in 1996—again without disagreements, objections, or conflicts (National Research Council, 1996, p. 72). Consensus was reached over the four years identifying "*More Emphasis*" conditions pertaining to all NSES sections, namely; Teaching, Professional Development, Assessment, Content, Program, and System. Most of the attention and arguments occurred with what ***content*** was to be included.

Though opposition to most of the above sections did not occur, the

More Emphasis features failed to transfer into classrooms. Most teaching continues to focus on what content to include and where. Without the commitment to teaching experience with inquiry and meeting the standards as envisioned by NSES, successes could not be realized.

Look at Us Now! illustrates the needed features of reform in science teaching. The examples included in this book provide models for all who are interested and ready for this real reform to take place—reform that leads to the meeting of all four goals of the NSES. Many classrooms and science teachers continue to use the discipline organization and teaching indicated in the "*Less Emphasis*" features. These were in contrast to the *More Emphasis* conditions which were the focus for what was envisioned in the 1996 Standards. The narratives contained within the chapters of this book describe not only the practices that each teacher author executed with his/her students, but also what it was they put into place to establish the *More Emphasis* conditions used to address the National Standards. Landsman and his team of teacher authors share their experiences and insights regarding the impact of change in their classroom culture when the *More Emphasis* conditions are naturally woven through the students' research investigations.

The *Research Investigation Process* (RIP®) professional development model supports the type of scientific inquiry experiences and impact described in the chapters in *Look at Us Now!* And it has clearly done this, at least in part, through achievement of the professional development *More Emphasis* conditions (see Chapters 1 & 12). Landsman and his team at *ANOVA Science* have executed their visions for "ideal" professional development with teachers across the U.S. This resulted in volumes of impact data in the form of assessment results and student and teacher products, and evaluation reports (for examples, see www.scientificinquiry.com/LOOKATUSNOW.htm and www.anovascience.com). Overwhelmingly positive consequences resulting from the use of scientific inquiry experienced by teachers led to the contributions reported in this book.

Using his extensive training and background as a research scientist who has conducted scientific investigations covering various fields of science from learning and experimental psychology to endocrinology to neuroscience, Dr. Robert Landsman, President of *ANOVA Science Education Corporation* created the RIP model of scientific inquiry.

From his own personal experiences as a student and witnessing student performance at top universities across the U.S. from the professor vantage point, Landsman found traditional approaches to instruction hindered the fostering of skills needed for critical thinking and decision making central to the scientific endeavor. Learners were not motivated. As a practicing scientist, Landsman realized and applied to the focus of his education model of inquiry the concept that scientists are motivated through their first-hand experiences with inquiry (scientific practices). The same type of experiences could motivate students and lead them to the same ends described in Goal 1 of the NSES: producing students who can "experience the richness and excitement of knowing about and understanding the natural world." In Chapter 12, he discusses the results of the initial implementation of the RIP model in a science academy that has been recognized as one of the best high schools in the United States by *U.S. News & World Report*. The results of a longitudinal study which compared two RIP schools with very different student population dynamics are also described in that chapter.

Teachers who use the RIP obviously incorporate the *More Emphasis* conditions to get the rigorous outcomes they achieved. This level of outcome for scientific practices can easily be achieved through this model of scientific inquiry, which illustrates seamless integration of the four STEM areas. One example is the kindergarten inquiry described in Chapter 2, *Spilling of Old Knowledge onto New Ways of Learning*, in which students engaged in a full and open inquiry to learn more about environments and how to undo some of humankind's negative influence on the oceans in the quest for fuels. In that inquiry, students are not only involved in aspects of planning and thinking through the investigation, but they conduct the entire study that tested their hypotheses about the best way to clean up an oil spill. They then continued on to design and build models that incorporated their findings that were achieved through their practicing of science. It also provides an example of engineering used for rich authentic assessment of what was learned through the practicing of science as well as the practical use of this information.

A middle school example of an inquiry based on the same ideas is *Eco-system & oil spill: Where scientific inquiry in the classroom meets reality*. It can be seen as a "feature RIP" at www.scientificinquiry.com. In that investigation, Melissa Miller's Kirtland, New Mexico, seventh graders designed and conducted a full and open inquiry to determine which of two commonly used methods for clean-up of oil spills really works the best on oceans and for prevention of shoreline damage. The students designed and then built model oceans as part of the method so that they were able to test their hypotheses.

The history of the NSES *More Emphasis* conditions is another key concept including information on how they were developed. They also indicate why they were and still are considered important for achievement of both the current NSES and the future *Next Generation Science Standards* (NGSS). The *More Emphasis* conditions are essential for any standards approach that stresses inquiry as a critical element. Scientific inquiry is content and ways to teach as recommended in the NSES. It is composed of the "scientific practices" that define the first of three Dimensions for the new Framework from which the NGSS are being developed (National Research Council, 1996; 2012, p. 41). The "scientific practices" that the Framework stresses for "Dimension 1" emphasize the "coordination both of knowledge and skills simultaneously." In the first draft of the NGSS (Achieve, Inc., 2012), at every grade level and for all content, at least one or more of the components of the behaviors and activities that characterize the "practices" of science are emphasized. At every grade level, students are expected to be undertaking complete investigations. To arrive at this destination, achievement of the *More Emphasis* conditions is necessary.

Thus, the NSES *More Emphasis* conditions were and *still should be* considered important for achievement of both the current NSES and the future NGSS. The stories told by the teacher authors in their chapters are fine examples of the outcomes being sought by the new Framework and the NGSS. The inquiries included targeting nonscience content areas which also require the students become proficient in content standard knowledge for those areas as they conduct their investigations.

In 2000, the National Research Council offered five Essential Features of Inquiry in K-12 science (National Research Council, 2000a, p. 29). These include: (1) Learner engages in scientifically oriented questions; (2) Learner gives priority to evidence in responding to questions; (3) Learner formulates explanations from evidence; (4) Learner connects explanations to scientific knowledge; and (5) Learner communicates and justifies explanations.

Landsman and the teacher authors illustrate well the power of "inquiry" and the use of the five Essential Features of the Inquiry learning focus. Each of the features also included (important) ways of illustrating Science, Technology, Engineering, and Mathematics (STEM) reforms. As major funding is proposed and offered there is certainly a need for agreement on what all of this means.

The contributions in this book were written by members of the audience it serves: the K-12 classroom teacher. Landsman has chosen his teacher authors for this book brilliantly, and I'm sure from his own experiences as a research scientist, middle and high school teacher, and university professor. In Chapter 1, Landsman and Kamimura present the rationale for the importance of stressing the *More Emphasis* conditions for achieving both the NSES and NGSS. Each successive chapter emphasizes one component of the RIP scientific inquiry-based critical thinking model and shows how this model leads to achievement of the *More Emphasis* conditions. It provides ways teachers can successfully implement inquiry in their classrooms. The content of each chapter clearly describes the actions taken and reasoning behind those actions to achieve the *More Emphasis* conditions. Taken together, Chapters 2 through 11 portray *how* all of the inquiry components fit together. Chapter 12 portrays the outcomes from using the RIP at the high school level.

The "Old" Standards were difficult to define as several drafts were developed and shared with all regarding specific content and discipline structures. There are many concerns with K-12 science content regarding what should be included and/or excluded. Real debate occurred—even with respect to the three "disciplines" finally used to define science in schools, namely life science, physical science, and earth/space science. The team developing the NGSS has decided to de-emphasize inquiry by name and instead use the term "practices" to operationally define inquiry. Operationally in the Old Standards "Inquiry" was defined both as content and as a way to teach. As the readers will see, the RIP model satisfies the terminology used by both the "old" and "new" standards that stands for what scientists actually do, without having to distinguish between scientific "inquiry" and "practices." After all, the founder of the RIP is a research scientist!

Dr. Landsman and the authors of this book decided to retain Inquiry as a major feature of new reforms. The efforts of the National Research Council in 1996 (and later in 2000) focused on Inquiry as the defining factor for the much needed reforms. One whole volume was offered in 2000 entitled: *Inquiry and the National Science Education Standards: A Guide for Teaching and Learning* (National Research Council, 2000).

The RIP scientific inquiry model already embeds the "scientific practices" described in the new Framework (National Research Council, 2012, p. 42): (1) Asking questions (for science [and for other content areas]) and defining problems (for engineering); (2) Developing and using models; (3) Planning and carrying out investigations; (4) Analyzing and interpreting data; (5) Using mathematics and computational thinking; (6) Constructing explanations (for science) and designing solutions (for engineering); (7) Engaging in argument from evidence; and (8) Obtaining, evaluating, and communicating information.

As the NGSS are being developed, the focus is on STEM (Science, Technology, Engineering, and Mathematics). The major problem is with the use of both science and mathematics as separate offerings for most school programs; now they are combined—even as mathematics was selected for the Common Core several years earlier. With the addition of technology and engineering more complications emerge. In the first draft of the NGSS there remain differences in terms of what content to include in the four areas and how it should be organized and combined.

The release of *Look at Us Now!* could not have been timelier. How scientific practices are mastered is just as important as the mastery of the practices themselves and this is a time of urgency for how the NGSS will be approached at the classroom level. The relevance of the content of this book is very important for the interpretation of how the NGSS will be approached at K-12 classroom levels. As you will discover, the scientific inquiry model presented in the pages of this book provides a tool for learning that can motivate students to learn in all content areas as well as bridge diverse content areas such as the 4 content areas of STEM.

It was learned in 2000 that most teachers and curriculum developers expect too little involvement of students. They are merely expected to follow directions from textbooks, lab materials, and teacher directions. Such teaching is not real inquiry for each student in each classroom! The ideal goal was “open inquiry” for every student; but five stages were offered—the last being “teacher guided” inquiry. Unfortunately this last category was selected by the majority of science teachers as they approached the Inquiry goal. In reality this meant teachers directing the inquiries for students to follow. It was a way to use inquiry—but it did not cause changes in the teaching nor apparently did it cause much positive outcome for student learning and motivation.

A critical issue is the dynamics which need to exist between the what and how and *too often the teachers feel forced to focus on the what, which are the standards*. The *More Emphasis* conditions were supposed to guide teachers through the how. The support to achieve this needed to be provided via professional development for existing teachers and university level curriculum reform for pre-service teachers.

The *More Emphasis* conditions are valuable tools as they offer criteria for teacher changes and self-assessment for these changes to occur by emphasizing what needs to happen (*More Emphasis* conditions) and de-emphasizing the instructional and assessment practices *that no longer* support the advancement of successful implementation of the standards.

James Paul Gee has called for real reform that the content needs to move beyond Mindless Progressivism common in most schools (Gee, 2012). Cullen, Harris, and Hill (2012) indicate well that a student-centered curriculum is important as illustrated by Landsman and his team of teachers!

The chapters of this book are offered to provide examples of the efforts of teachers who are actually putting into place the *More Emphasis* conditions to assist others with the current reforms. The practices used by scientists to gather information and learn about the world (referred to in the NSES and NGSS as "scientific inquiry") are core components of what teachers and students should be performing in their classrooms as they both learn the nature of real science.

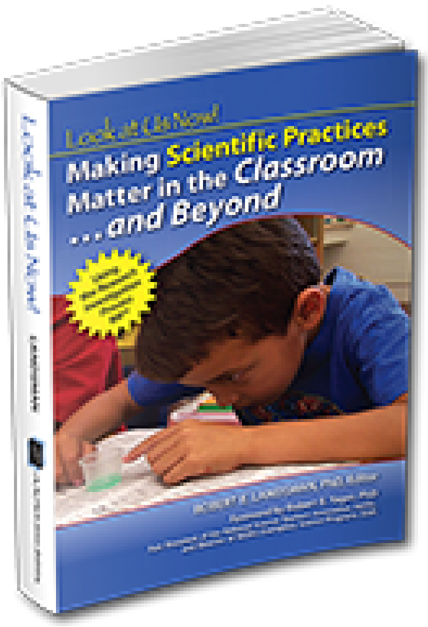
Appropriateness and use of the RIP scientific inquiry model for teaching extends well beyond science to target nonscience content (e.g., Chapter 5: *RIP~ing beyond science with slippers and M&M's* (social studies and math), Chapter 7: *The special needs student and scientific inquiry: A successful tale* (language arts), Chapter 9: *S-c-i-e-n-c-e in the class spells fun!* (language arts) and Chapter 10: *Should I keep my lucky socks?* (language arts and social studies), and brings out student excitement for learning and critical thinking across STEM and non-STEM content areas.

It is common for science programs and teachers to say that they encourage critical thinking through what they teach and what students learn. However, asking teachers to specify and explain how and what is actually being done and practiced by their students to foster critical thinking skills almost invariably results in fuzzy responses such as "my students have to think when learning science." The "what and how" are never included. From chapter to chapter, this book abounds with instances of critical thinking occurring through the practice of science in which students are attending to details, questioning assumptions, combining complex material in explanations, and using evidence to support argument. It doesn't stop there—the impact continues beyond high school and into higher education and influences career choice/performance and personal life. Real life examples of students' gains not measurable by typical assessments are presented in Chapters 12 and 13. The *Look at Us Now!* book is full of rich ideas and experiences embedded with current reforms which will influence the future NGSS.

None want to use the "old" Standards as the year 2013 emerges! But, do the NGSS ones now proposed illustrate what we have learned and done over the past 16 years? Landsman and his group have now exemplified the way real reforms can be achieved.

Look at Us Now! is a timely and powerful message for improving education—most specifically the needed reform of teaching. It should be a collaborative effort for teachers and students as they use the *More Emphasis* features to realize the type of reform that transforms teaching and learning in *all* classrooms!

Robert E. Yager



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