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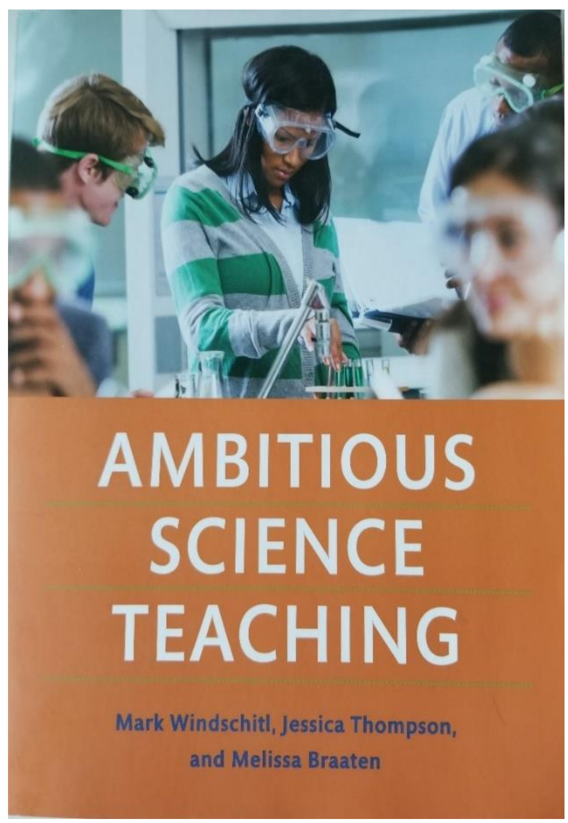
Ambitious Science Teaching (AST) is a fresh approach to instruction and differs from Project Based Learning (PBL) and Understanding by Design (UbD) in its method of teaching and learning of science. The difference is that teachers who employ AST actively solicit the ideas of students, engaging them in multiple rounds of creating and revising scientific models, explanations, and evidence-based arguments. AST is for all science teachers, but particularly for those working in schools where funds are limited but student potential is immense. The concepts of AST allow teachers to develop science programs that creatively enhance the learning experiences of the students irrespective of socioeconomic, racial, or geographical differences.



In *Ambitious Science Teaching*, authors Windschitl, Thompson, and Braaten investigate how science practices – regardless of the grade level – can be stimulating, motivating, and rewarding for both student and teacher. AST is an alternative pedagogy that enhances traditional teaching practices.

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AST involves the application of creativity and critical thinking to spur insightful and engrossing lessons that promote student engagement. Unlike traditional approaches grounded in specific pedagogy, AST is heuristic and organic, focusing on the learning of science from the vast and diverse experiences that students bring to the classroom. AST allows for immediate application of science topics and emerging questions and curiosity from students. The goal is for students to enjoy the learning and applications of science based on how students engage and interact with the natural world. Students then can see the relationships between topics presented by reflecting on scientific and relevant real-world applications through a collaborative learning experience.

The authors understand the challenges of teaching science in schools that have limited funding and less-than-ideal conditions, and of honing science curriculum to support student learning. All former science educators, each author taught at the University of Washington and led the teacher preparation program for secondary science. During their tenures, Windschitl, Thompson, and Braaten concluded that future science educators lacked the basics skills to actively engage students in the classroom. This spurred them to develop an innovative program with courses that could be incubators to advance curriculum development in novice teachers' classrooms. The specific vision of AST was to improve the work of the Carnegie Foundation for the Advancement of Teaching by empowering teachers to drive change in a teacher-centered approach. The ultimate goal of the AST authors was to immerse novice teachers in the program; thus, live action research of teaching instruction immersion became the standard to evaluate the program for continuous improvement in a public setting. Theory in action became the goal and mantra of AST. AST has evolved over the course of 12 years, tested by hundreds of science teachers, from pre-service to seasoned veterans.

The book contains strategies on how to develop effective science lessons for all grade levels, in which learners experience multiple representations or experiences of learning, which could assist pre-service teachers as they become more comfortable in implementing hands-on science practices with their students. The active student-centered approach supports critical, reflective, and reflexive thinking. The book also describes each of these practices and how the final products developed by the students led to further exploration, and how to hone the objectives of different lessons in the AST program.

The AST model was originally designed to enhance middle school and high school programs, and eventually expanded to the elementary level, including kindergarten. The AST approach complements the Next Generation Science Standards (NGSS) in terms of pedagogy and structure. Additionally, the lessons developed lend nicely to further student exploration of topics, with the overall focus of a student-centered approach to the learning and application of science. The following topics are defining aspects of AST.

Empowering Learners and Teachers

Immersing teachers in a thoughtful, reflective, and reflexive habit of thinking about their work could support continuous improvement of practice. Many examples and suggestions within the AST model help teachers to develop the habit of reflective thinking that advances curriculum thinking. One example is the three part lesson planning triangle. The model asks teachers to think critically on the relationship between the standards to be met, the gapless explanation for anchoring the event, and student learning based in learning experiences and activities. Each phase of the model provides reflective questions as to how the lesson should be developed with the student in mind while scaffolding learning for achieving mastery of the standards. Throughout the book, the authors include actual student work at different grade levels to illustrate what teachers who are planning to use the AST program may expect from their students as products. The models are a general representation of how students may think, their creativity in applying the scientific method, and application of learning in action of science topics and themes. Students may come up with ideas and solutions based on their own life experiences, their own knowledge of the topic, and the ways in which they choose to implement their newfound knowledge.

Learner Centered and Learning for Tansfer

The authors have effectually argued that there is a need to create AST to support all students in developing critical thought and to apply these processes to their day-to-day lives. The development of scientific thought and reasoning will allow students to be successful not only in the sciences, but to use those same skills learned, honed, and mastered in any field or profession they choose to pursue. The authors believe there is a need to integrate the tenets of AST by continuously evaluating the teaching of science for relevancy within the classroom and to enhance the learning of the student population being served.

According to the authors, what classroom teachers do with the curriculum and resources they have on hand has the greatest impact on student learning and achievement. Ensuring active student engagement with the curriculum is much more influential than any specific program or curriculum a school may possess. Learning becomes student centered when led by student-generated questions and interactive dialogue with peers and teachers. Both veteran and preservice teachers (the next generation of educators) who do not exclusively rely on pre-existing curriculum, but instead follow learner curiosity, will experience greatly enhanced professional development in using AST.

Teachers' Live Action Research Through Teaching Instruction Immersion

The authors do not just focus on student engagement and critical thinking skills. They seek to assist novice and veteran teachers in working collaboratively to improve science teaching, or in other words, to apply action research to professional praxis, perhaps in a professional Learning community (PLC). These PLCs are currently used in numerous school districts throughout the U.S. to support teachers by scheduling weekly mandated collaborative time to discuss and focus on the relevant issues within the school. Discussions include how to improve student mastery, learning, and application of science. Within the PLC and during the collaborative times with other science educators, the three questions that are asked most often are, "which practices work best in *our* classrooms; under *which* conditions do these practices work best; and for *whom*?" (p. 237). By employing these three questions to help guide science teaching, the educators who integrate the AST model may find that these prompts actually help in the development of curriculum and lesson plans for their local schools, while probing ongoing issues of inequity within the school setting. By taking a hard look at who is and is not learning, there is a greater probability that issues of inequity in teaching and in learning can be addressed. The idea of the program is to provide not only challenges but also opportunities within PLCs to support teachers to further develop science programs that will improve learning outcomes for all students.

Equity in science instruction is discussed throughout the book and is a foundation for improving student learning and engagement. The authors noted the importance of drawing attention to equity in teaching and the impact on students' learning. Students may believe that learning science is unattainable if they do not have the tools, language, or support needed to be successful. To narrow the equity gap, the authors suggest teachers "situate learning in familiar or everyday contexts" (p. 10). As a lesson unfolds, the teacher should be responsive to how students are contextualizing the information based on their personal experiences and the questions that may arise. Teachers supporting equity in science education give students permission to generate and defend their own ideas based on personal experience. Additionally, teachers should employ frequent formative assessments that will allow students to demonstrate acquisition of knowledge. Formative assessment can vary based on the curriculum to include writing, art, and verbal expression, but should not be solely grounded in quizzes or tests. Chapter 13 includes examples of how teachers can be successful in engaging students in meaningful science learning by using various practices and infrastructures that are found in many schools.

Developing Effective Science Lessons

The book addresses how to actually present science topics and ideas to students. As the authors noted, there is not a "step by step recipe for flawless forms of interactive direct instruction" (p. 159). Instead, teachers who plan to implement the AST program need to be flexible in their approach to engaging students in the process. The goal is to have students think along with the teacher and to brainstorm the resources that are needed in order to solve the science problems that they will be investigating. Students will be able to use critical thinking and their prerequisite knowledge to determine what type of resources might be the best needed to demonstrate mastery of the topic. Students not only will be able to connect previous ideas and activities that they have learned, but also determine what type of information or experiences they will need to move their thinking forward when presented with a new problem.

Learning Through Multiple Experiences

Prior to taking on a project, students will also learn how to incorporate the vocabulary that was introduced by the teacher for the specific topic in the appropriate context. Students are provided with some structure on how to respond to these newly introduced topics and ideas, yet they will have the opportunity to apply and expand their knowledge by using different forms of representation such as drawings, diagrams, computer simulations, mathematical formulas, and models. Throughout the book, numerous diagrams illustrate various ways teachers can actually introduce new science topics and ideas. Graphic organizers, checklists, and detailed visuals showcase how science educators can actively engage their students in not only the learning of science, but in teaching the topics to one another. The peer-to-peer teaching process provides the opportunity for students to be cognitively aware of language that they are using to convey scientific thought and how to properly integrate the science vocabulary that they have learned in the proper context.

Each chapter ends with a section called "How to Get Started," containing activities to help the reader implement the topics reviewed in the chapter as well as specific ideas to develop with a colleague or independently. These sections also provide recommendations based on the authors' prior teaching practices and suggestions made by AST practitioners. For example, in the chapter "Making Thinking Visible Through Models," the "How to Get Started" activity suggests students practice developing a model in the context of a single lab activity. This activity provides a platform for students to focus on one specific activity within a unit instead of completing a model that is representative of all topics within the same unit. The authors also suggest that AST practitioners provide simple directions and templates to help guide their students through each of the different steps.

Critical, Reflective, and Reflexive Thinking Skills

The supplementary value of this book is in the tools and resources that are provided directly to the educators in how to help students understand the process of explaining their work, moving away from rudimentary responses to thinking critically, reflectively and reflexively to support their opinions based on observations and scientific fact. The authors have developed the process of the what, how, and why levels of explanation. Each of these levels supports the foundational work of AST by providing students a platform to comprehend the direct relationships and the relevance of the subject content areas they are learning with regard to everyday life. When students have the opportunity to look at the most minute detail and the grander picture, they can directly relate their knowledge to the world around them. The most current example is that of climate change. We can look to Greta Thunberg, a Swedish climate change activist, and how she has been able to use the tenets that are found in science and a program such as AST to bring awareness of the effects of climate change on her generation and future generations. She was able to make sound arguments based on her knowledge of science not only to her peers but to members of the United Nations. She is just one example of what students can do if they are given the tools by their teachers to develop the critical thinking skills needed to be successful in the sciences.

Summary and Conclusion

In the last five years, no other book has tackled this topic with a sole and in-depth focus on the teaching of science in a manner that is thorough in its logic and application. That this program, Ambitious Science Teaching, has stood the test of time over the last 12 years makes a strong case for the use of integrating academic and effective pedagogy in science education programs. This book may serve as a valuable resource for all science educators regardless of the grade level or the school in which they teach.

The value of this book for preservice and veteran science teachers is multifold: the organization of the topics, the examples, the guidance, and the resources for professional development. In one of the appendices, the authors remind educators of the bigger picture of instruction. Science educators must always think about how the topics that they are introducing to their students have a trajectory, from the smallest observation, to connecting concepts from one lesson to another, through the critical thinking capacities of their students. Examples for teachers, which are developed at a level that students can easily comprehend in the areas of the writing of science, drilling it into data, and making sense of experimental design, are provided throughout the book.

As a science educator and coach, I have seen first-hand the level of wonder, energy, and enthusiasm that occurs in the classroom when students are engaged in the AST model. For students, learning science is an exciting exercise in creative discovery that is contagious. For me, science became fun again when teaching and coaching using AST. I was able to show to students my passion for the sciences and be a kid again, thinking critically and creatively with reckless abandon. As an administrator and education coach, I truly treasure the opportunities to visit a classroom that is integrating the AST model and see students in awe of science.

About the Reviewer

Cheryl Burleigh, Ed.D., is contributing faculty for the Richard W. Riley College of Education and Leadership at Walden University. Her teaching focuses on curriculum and instruction, school leadership, ethical decision making, education law, and education equity for graduate students pursing master's and doctoral degrees. She has a passion for projects that intersect empowering females in the sciences and arts in positions of leadership.

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