Benjamin Bloom’s Taxonomy of Student Learning attempts to classify the behaviors associated with learning into levels (Bloom et al., 1956). Bloom’s original levels of learning included three lower levels (knowledge, comprehension, and application), and three higher levels (analysis, synthesis, and evaluation). This taxonomy spurred the development of the concept of higher level thinking skills, which are so important to educational practices to this day. The updated levels of Bloom’s Taxonomy are: Remember, Understand, Apply, Analyze, Evaluate, and Create (Anderson & Krathwohl, 2001). Thus, Create is considered to be the pinnacle of learning and so might be postulated to be best developed among gifted learners. Unfortunately, much of our current educational and testing constructs focus on the very basic foundation of learning Remember/Knowledge, which focuses on having students memorizing facts. The remaining components of the hierarchy are often neglected even for our most capable students. Thus, science instruction often focuses on content knowledge with students being expected to memorize numerous facts and formulas that relate to the natural world.

In many instances, talented and gifted (TAG) education also focuses on this lowest level of learning and merely consists of either having gifted learners process greater quantities of content (enrichment) or having them memorize the various fact and formulas at a younger age (acceleration). This approach is particularly problematic for science since the facts of science are in constant flux such that much of what students are taught during their precollege years will no longer be scientifically accepted by the time they either enter or complete college. For example, many of us learned that there were nine planets in our solar system and that single cell animals were the simplest animals. However, now we are taught that there are eight planets in the solar system since Pluto was reclassified as a plutoid or dwarf planet based on its size and location in space; and the concept of single celled animals is nonexistent due to the fact that there is a separate Kingdom for all single celled eukaryotes.

While the content of science is constantly evolving, the general process skills of science have remained unchanged. Additionally, the mastery of these process skills, especially the higher level process skills, is necessary for success in the sciences and often defines truly great scientists. The ability of scientists to ask the right questions (Create), to discern the way to investigate these questions (Analyze), and to evaluate
their findings (Evaluate) is what sets them apart from the technically competent bench scientist who can carefully follow a set of experimental procedures. The idea that creativity is important to the successful scientist was eloquently described by Albert Einstein (1931). “I believe in intuition and inspiration. Imagination is more important than knowledge. For knowledge is limited, whereas imagination embraces the entire world, stimulating progress, giving birth to evolution. It is, strictly speaking, a real factor in scientific research.” Thus, it is critical for gifted learners to be taught how to create new postulates, to think logically and to reason rather than to be taught strategies to memorize a set of potentially irrelevant facts.

CHAPTER SYNOPSIS

This book contains twenty chapters divided into five sections, which explore the interplay between creativity and giftedness in science. The first section titled “Historical Perspective” includes three chapters, and provide a historical context for the book. In “Historical Contribution of Creativity to Development of Gifted Science Education in Formal and Informal Learning Environments,” Lynne Bailey and colleagues trace the history of gifted science education. In the next chapter, “Importance of Creative Thinking for Paradigm Shifts that Foster Scientific Advances,” Miheyon Kim examines the many aspects of creativity (i.e. imagination, intuition, insight and inspiration) that sustain the work of scientists, like Einstein, to progress in revolutionary scientific discoveries that result in paradigm shifts. Trudi Gaines, Jennifer Mesa, and John Pecore in “Twentieth Century Scientists who Exemplify the Interplay of Creativity and Giftedness” present the biographies of Luis Walter Alvarez, Barbara McClintock, and Peter Dennis Mitchell; three Nobel scientists who epitomize creative giftedness, and through the telling of their life experiences reaffirm the role of the environment in fostering creativity.

Section 2, which includes three chapters, is titled “Encouraging Scientific Creativity in gifted Learners.” First, Erin Peters-Burton and Lisa Martin-Hansen in “Implications of Gifted Student Selection Techniques for Scientific Creativity” address issues with current metrics to identify scientifically creative children and the need for tests that better recognize scientific creativity when identifying gifted students. The next chapter, “Efficacy of Creativity Training for Gifted Science Students,” by Anthony Washington and Lori Andersen discuss strategies for increasing gifted science students’ engagement and developing creative skills. Then, Angela Stott and Paul Hobden in “A Belief System at the Core of Learning Science: A Case Study of a Critical and Creative Gifted Learner” present the belief system central to the self-regulated learning for science of André, a gifted learner, and describes his observed cognitive strategies motivated by critical and creative thinking.

The third section, “Developing Gifted and Creative Learners in Science Education Classrooms,” contains four chapters that provide strategies for cultivating creativity in gifted learners. In the first chapter, “Mind your P’s and E’s: Developing Creativity
their findings (Evaluate) is what sets them apart from the technically competent bench scientist who can carefully follow a set of experimental procedures. The idea that creativity is important to the successful scientist was eloquently described by Albert Einstein (1931). "I believe in intuition and inspiration. Imagination is more important than knowledge. For knowledge is limited, whereas imagination embraces the entire world, stimulating progress, giving birth to evolution. It is, strictly speaking, a real factor in scientific research." Thus, it is critical for gifted learners to be taught how to create new postulates, to think logically and to reason rather than to be taught strategies to memorize a set of potentially irrelevant facts.

CHAPTER SYNOPSSES

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The third section, "Developing Gifted and Creative Learners in Science Education Classrooms," contains four chapters that provide strategies for cultivating creativity in gifted learners. In the first chapter, "Mind your P's and E's: Developing Creativity in the Science Classroom," Claire Hughes and Timothy Goodale present a model that integrates science content instruction with the development of creativity. Next, Lina Soares advocates for providing hands-on and minds-on investigative inquiry experiences to foster curiosity and stimulate creative ideas in "Sciencing: Creative, Scientific Learning in the Constructivist Classroom." In "Quantifying the Effects of Personalized Assessment Tasks in Secondary Science Teaching," Adele Schmidt examines a chemistry programs impact of teaching and learning strategies on fostering personal engagement and creative thinking while upholding foundational knowledge. Then, Andrea Foster in "Fostering Creativity in Science Classrooms: Lessons Learned from a Brigadier General" highlights the significance of school experiences and the need for early identification of scientific talents to developing and nurturing gifted children.

Six chapters are included in Section 4, "Science, Creativity and Giftedness in Real World Contexts with Diverse Learners," which features a variety of settings for investigating creativity and science in diverse gifted learners. First, Tang Wee Teo, Jia Qian Woo, and Lay Kuan Loh in "Affordances in School Science Research: Narratives from Two Singapore Specialized School Students" examine, through the concept of affordances, the science research experiences of two high school students. Next, Jerry Everhart in "The Geography of Giftedness: Growing Scientists in Rural Areas" addresses three issues (space, readiness, and plan-of-action) that impact the transition of gifted rural students to studying science at university. In "Identifying Gifted and Creative Future Scientists who are Linguistically and Culturally Diverse," Maria Arreguin-Anderson and colleagues suggest changing the practice and ideology in the field of gifted education in order to open spaces in the science fields to the linguistically and culturally diverse gifted learner. Then, Corin Goodwin and Mika Gustavson in "Science, Creativity and the Real World: Lessons Learned from the U.S. Homeschool Community" advocate for valuing homeschool education as an existing resource for learning about fostering creativity in science. The next chapter is "Science Creativity within the Rules: Suggestions for Teaching Science to Gifted Children with Autism." Here Lauren Madden and Kristin Dell’Armo provide two examples of successful adults as examples for nurturing scientific creativity through classroom environments for students on the autism spectrum. Then Sally Carson, Steve Cutler, and Victoria Rosin in "Creatures, Costumes, Cryptic Creations: Integrating Creativity in a Secondary Science Gifted Program in Marine Science" present findings from New Zealand's Talent Development Initiative for integrating creativity in a residential science program.

The final five chapters in Section 5, "Approaches for Fostering Scientific Creativity in Gifted Learners," highlight innovative programs that promote creativity in gifted science education. In "Use of Analogy and Comparative Thinking in Scientific Creativity and Gifted Education," Audrey Rule and Benjamin Olsen discuss the applications of analogies as an essential component of science and gifted education. Then Keith Tabor in "Chemical Reactions Are Like Hell Because...": Asking Gifted Science Learners to be Creative in a Curriculum Context.
that Encourages Convergent Thinking" shares the use of a science analogy game to encourage creativity in secondary science teaching. In "Fostering Creativity Using Robotics Among Students in STEM Fields to Reverse the Creativity Crisis," Kyung Hee Kim and Steve Coxon discuss the creativity crisis and the potential for robotics programs to foster creativity. In "Attracting Dynamos: How Problem Based Science Opens Doors and Creates Opportunities," Mary Lightbody and Lisa Huelskamp discuss the use of problem based learning computer simulations to both attract gifted students to science and meet the needs of tomorrows science leaders. Finally, in "Developing a Rebel With a Cause through Creative Risk-Taking in Gifted Students," Carrie Rainwater and Nancy Wittner discuss ways for gifted students to gain confidence in taking risks associated with creative approaches to scientific problem-solving.

REFERENCES


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