Guest Editorial

Nanotechnology manipulates and assembles matter on an atomic and molecular scale to create materials and devices with unique, new properties. Nanotechnology education is interdisciplinary, in that it involves different fields such as nanofabrication, nanomechanics, nanomaterials, nanophotonics, nanoelectronics, nanofluidics, Nano-Electro-Mechanical Systems (NEMS), and computational methods on the nanoscale.

In recent decades, innovation in nanotechnology has substantially increased the growth of new applications, such as electronic devices, disease identification and management, and energy production and storage. Many researchers believe that nanotechnology is one of the fastest growing industries in history. In 2007, The National Science Foundation in the United States predicted that nano-related goods and services could be a $1 trillion market in 2015, and that the United States will hire 800,000–1,000,000 nanotechnology workers.

Although the research community believes in the infinite potential of nanotechnology to benefit humanity, the general public hardly shares the same knowledge or enthusiasm. Surveys show that no more than 20% of the adult population in the U.S. can provide any sort of definition of nanotechnology. People appear to have far less awareness or interest in nanotechnology than other emerging technologies such as stem cell research, biotechnology and genetically modified food.

People's perceptions about nanotechnology often arise from science fiction, rather than formal nanotechnology education. In 2003, Prof. Richard Smalley at Rice University, a Nobel Laureate in Chemistry, conducted a survey of hundreds of high-school students in Houston, Texas, USA. He was surprised at the survey results—nearly half of the students assumed that the self-replicating nanomachines described in the novel "Prey" by Michael Crichton were possible, and most students were deeply worried about what would happen in the future as these nanomachines spread around the world.

With this special issue, we aim to bridge the gap between nanotechnology research and education. We also aim to facilitate the development of more effective nanotechnology education and outreach programs, so that we can equip our students to adjust to the ever-changing scientific world and enable them to develop into future leaders. Example topics for the special issue include:

- Certificate programs and degrees in nanotechnology education
- Integration of nanotechnology into engineering curriculum
- Implementation examples and issues
- Courseware development
- Evaluation and assessment
- Good practice examples
- Industry-university (or university-university) partnerships
- Curriculum development in nanotechnology education
- Instructional design for nanotechnology education
- Marketing/promoting nanotechnology education
- Pedagogical issues
- Research perspectives for nanotechnology education
- Simulations and tools
- Societal and ethical issues
- Virtual (or remote) universities, classrooms, and laboratories
- Education and outreach
- K-12 nanotechnology education

To achieve the aforementioned goals, this special issue includes nine papers covering a range of important topics on nanotechnology education: (1) curriculum integration, (2) instructional design, (3) evaluation of computer simulations, (4) research trends, (5) ethical and societal issues, and (6) K-12 nanotechnology education. These papers are briefly described as follows.

Curriculum integration

Santosh Devasia and Jim Borgford-Parnell integrate the design aspects of nanopositioners into an undergraduate automatic controls curriculum at the University of Washington, Seattle, USA. Such integration allows mechanical engineering students to explore the application of course concepts in the field of nanotechnology.

Instructional design
Charles Xie and Hee-Sun Lee present a visual approach to teaching concepts in nanotechnology by using interactive computer simulations. Five mathematical models used for creating the computer simulations are explained. They report the results of a quantitative pilot study conducted in an introductory solid state physics course at the University of California, Santa Cruz, USA, in order to validate the effective use of these computer simulations in the classroom.

Evaluation of computer simulations
Alejandra Magana, Sean Brophy, and George Bodner from Purdue University, USA, conducted two studies on students' and professors' perceptions of using online nanotechnology computer simulations as learning tools at nanoHUB.org (the Network for Computational Nanotechnology funded by the U.S. National Science Foundation). In their first exploratory study, they investigated science and engineering students' perceptions of using these computer simulations. They collected and analyzed both quantitative and qualitative data.

Their second study analyzes engineering professors' perceptions when integrating the computer simulation tools into their curricula. Technological Pedagogical Content Knowledge (TPCK) is used as the theoretical framework of this qualitative analysis.

Research trends
Deepa Chari, Paul Irving, Robert Howard, and Brian Bowe from Dublin Institute of Technology, Ireland, use a qualitative approach to investigate postgraduate researchers' perceptions and experiences in nanotechnology education. The study identifies knowledge, skills, and competencies necessary to improve future nanotechnology education research.

Ethical and societal issues
Eva Toth and Kasi Jackson from West Virginia University, USA use a mixed method approach, with pre- and post-instruction design, to examine students' perspectives and reasoning with regard to the societal and ethical effects of nanotechnology discoveries.

K-12 nanotechnology education
Our next three papers focus on next-generation nanotechnology education. Beth Sockman, John Ristvey, and Christine Jones use a design-based research methodology and qualitative theme analysis to examine high school students' perceptions of nanotechnology. Their findings highlight themes and trends in students' understanding of the new technology.

Tzy-Ling Chen, Horn-Jiunn Sheen, Hsiu-Ping Yueh, Feng-Kuang Chiang, and Po-Wei Chang analyze data from a nanotechnology summer camp designed for Taiwanese high school students to explore nanotechnology. The curriculum design is based on David Kolb's experiential learning theory.

Finally, Christopher Moraes from the University of Michigan uses soap bubbles as an example of molecular systems in order to illustrate the complex principles of self-assembly in a nanotechnology outreach program for high school students.

On behalf of all the authors and reviewers contributing to this special issue, we would particularly like to thank Editor-in-Chief Ahmad Ibrahim for his continued support to our scholarly efforts. We hope you will find these papers informative and useful. Any feedback would be greatly appreciated.

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Guest Editors