#### George C. Pimentel Award in

**Chemical Education to Pratibha Varma-Nelson**

George C. Pimentel Award in Chemical Education sponsored by Cengage Learning and the ACS Division of Chemical Education

**Symposium**

**Location:** New Orleans Marriott Convention Center

**Date:** Tuesday, March 20, 2018

**Organizer and Presider of Symposium:** Diane Bunce

**Presentations**

Support by the National Science Foundation for the development of peer-led team learning

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The use of Peer-Led Team Learning (PLTL) by the national STEM community has expanded exponentially over the almost-thirty years since its initial introduction in the early 1990's as Workshop Chemistry with funding through the National Science Foundation (NSF). In 1994 the NSF introduced the Systemic Changes in the Undergraduate Chemistry Curriculum Initiative, designed to support large-scale, multi-institutional projects that would make substantial changes in the design of the undergraduate chemistry curriculum, with a focus on the first- and second-year courses. PLTL formed the basis of one of the five projects that were funded under this Initiative. The PLTL project was the narrowest in design and the easiest pedagogical change to implement without revising the entire structure of a given course or curriculum. Thus, while all five funded efforts have achieved significant impacts across the national chemistry community, PLTL rapidly became the most identifiable and most easily disseminated of the five projects. This characteristic helped PLTL gain support for major dissemination grants from the NSF in 1999 and 2003 to further expand the implementation of this pedagogy across the national chemistry community. Under these grants PLTL explored the use of Workshop Project Associate (WPA) grants, small grants to other institutions interested in implementing PLTL on their campuses. With intellectual and practical support from faculty experienced in using PLTL, the WPA grants succeeded in expanding the national reach of PLTL to many additional institutions and to other disciplines. Over time the PLTL community has attracted major support from other foundations in addition to NSF to actively continue broadening and refining efforts in development, dissemination, evaluation, educational research, and cyber applications of this instructional model.

PLTL: A multidisciplinary intervention to ensure success in STEM gatekeeper courses at Morehouse College

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Peer Lead Team Learning (PLTL) workshops were first piloted in the Department of Chemistry at Morehouse College in 2004 in a single general chemistry course. After a successful piloting phase, PLTL was ultimately institutionalized across all sections of the introductory courses (general and organic chemistry) within the department, with full integration of PLTL workshops occurring in place of the traditional recitation sections. After establishing the impact that this intervention had on the successful completion rates in these courses, PLTL expanded throughout the Division of Science and Mathematics at Morehouse -- with either pilot or course-wide implementations taking place in Biology, Physics, Mathematics and Psychology. By 2009, Morehouse had established itself a regional leader in PLTL implementation and hosted a national conference to disseminate best practices associated with the implementation of successful PLTL programs. A description of the timeline for this multi-discipline implementation and our "lessons learned" will be discussed.

**Three Big P's: POGIL, PLTL, and Pratibha**

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The POGIL Project formally began in 2003, but its roots extend back into the 1990s with the NSF -funded New Traditions Systemic Initiative and Multi-Initiative Dissemination Project. In this presentation, I will use The POGIL Project as a case study for how a pedagogic reform can grow and become broadly disseminated, and I will discuss the key roles that Dr. Pratibha Varma-Nelson played in that evolution.

Oh, the places you'll go: The dissemination and implementation of the peer led team learning project, a unique student-faculty partnership

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At the center of the successful proliferation of the Peer Led Team Learning model was the unique student­ faculty partnership. This symposia discourse will describe and discuss the role that this pivotal partnership played in the dissemination of the PLTL project to aid it in it being incorporated into classes in over 150 institutions of higher learning and into various STEM discipline classrooms through the perspective of a former student PLTL peer leader. The PLTL project leadership along with their student leaders traveled across the country and participated in Gordon Research Conferences to seek out and teach willing and sometimes hesitant faculty and students how to successfully implement the PLTL model into their classrooms. This student-faculty partnership extended into the Workshop Project Associates (WPA) grant program and served to aid interested faculty in successfully implementing PLTL into their curriculum and in developing strong partnerships with their own students. Along with this discussion the training and transformation of student peer leaders and faculty themselves will also be discussed.

Implementation and evolution of PLTL in introductory computer science courses

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We discuss the implementation and success of a program that uses active recruiting and peer-led team learning (PLTL) to increase the number of women and underrepresented groups in introductory computer science courses at the college level. A collaboration of eight universities applied these strategies in a study that ran from 2004 to 2008. The study showed several benefits including recruitment and retention of students in those courses, and leadership experience and opportunities for personal growth for the peer-leaders. With the soaring popularity of computer science as a major in college the past five years, we further discuss how PLTL in computer science has evolved to support large courses and provide even larger leadership roles for undergraduate peer-leaders.

Peer led team learning applied to laboratory instruction

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Problem-solving (PS) and inquiry-based (IB) laboratory experiments offer numerous advantages over demonstration (i.e. cookbook) experiments. Despite their clear advantages, PS/IB experiments place significantly greater intellectual demands on students. As a result, the potential benefits of PS/1B experiments often go unrealized. This leads to frustration for both students and instructors. We have responded to this pedagogical challenge at the University of Rochester by applying the Peer Led Team Learning (PLTL) model to laboratory instruction. Recent efforts to design, implement, and evaluate the PLTL model for laboratory instruction will be described. Topics to be discussed include: the design of appropriate discussion problems (pre-lab, in-lab, and post-lab), logistics, leader training, student feedback, and the evaluation of learning outcomes. New laboratory space designed to facilitate PLTL in the lab will be briefly described.

PLTL: Experience from both sides of the desk

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As an undergraduate student I was able to engage in PLTL as a peer, a leader, and a leader trainer at the undergraduate and high school level and now as an educator I am incorporating PLTL into a new undergraduate Bioengineering degree. We will review the experience that each unique role has played in learning science and learning how to teach science. My experience as an undergraduate organic chemistry student in a PLTL environment sparked my interest in education research and resulted in my becoming a peer leader the following year. As a peer-leader and peer-leader trainer PLTL the experience led me to discover my interest in teaching and how to develop an environment conducive to the students truly understanding the material. Prof. Varma-Nelson and myself continued to collaborate following my graduation on integrating the PLTL model at a local high school and further disseminating the PLTL model to NEIU and Purdue. At McGill, I joined the Dept of Bioengineering as the first faculty member and have created several undergraduate and graduate classes that were influenced by the experiences I had working with Prof. Varma-Nelson.

**From face-to-face to online: Collaboration in design and implementation of cPLTL**

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The ideas, the people, the conditions, and the technology tools required to offer Peer-Led Team Learning (PLTL) online met at the right time - leading to the collaborative creation of cyberPLTL (cPLTL). We will review the inception of cPLTL with a primary focus on the student-faculty synergy and conditions that allowed adapting an educational strategy that was proven beneficial in STEM courses in a face-to-face environment to an online format. We will discuss the pitfalls and progression of utilizing and working in an online collaborative learning environment with various types of technology while conducting PLTL Workshops online. Preliminary impact for students in the general chemistry course and our initial evaluation of the effectiveness of a cPLTL environment in duplicating the proven benefits of the traditional (face-to-face) PLTL method will be presented. Student and leader training developed and provided by our student-faculty team in order to prepare the participants for working and learning within the cPLTL environment will also be highlighted.

**Peer-led team learning in science and engineering at IUPUI**

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We review our experiences with incorporating peer-led team learning (PLTL) at IUPUI. PLTL is a socio­ collaborative learning method utilizing small groups of students engaged in active problem-solving led by a slightly advanced student. With the support of the Center for Teaching & Learning directed by Dr. Varma­Nelson, face-to-face and cyber PLTL workshops were integrated into organic chemistry leading to increases in retention. A new initiative is to introduce a peer-led undergraduate research initiative (PLURI) into second­ semester organic lab. Navigating the challenges of offering an authentic research experience with an unselected student group is an ongoing experiment. We aim to assess changes in students' perception of research and deeper interest in STEM fields. In computer science (CS), education traditionally has been agentic, where a single student is expected to master a computer using classroom lectures as guides. This model frequently leads to stereotyping of computer scientists as nerdy, unsocial, males, and often leads to a failure to succeed and develop a sense of belonging, particularly for women and other under-represented minorities who thrive in a more collaborative environment. PLTL can overcome such stereotypes. PLTL was implemented in introductory CS courses and has anecdotally resulted in significant improvement in retention. Research is underway to implement similar approaches throughout the curriculum and to evaluate their impact on learning and sense of belonging using methodologies from social psychology. Engineering & Technology has been using PLTL workshops in sophomore level Biomedical Engineering laboratories, introductory Engineering Thermodynamics and Mechanical Engineering Statics for 2 years. PLTL workshops have increased hands-on problem-solving time, helped students develop problem-solving strategies, and increased sophomore retention. In both science and engineering, professional development of student leaders is an additional strong attribute of PLTL workshops. A leadership curriculum is being piloted by the Technology Leadership & Communications department for these students.

Theoretical cognitive foundations for peer-led team learning

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Choices in curriculum design should be informed by knowledge of how students construct knowledge. Development of the Peer-Led Team Learning project was enlightened by an understanding of the works of L. Vygotsky and J. Piaget. This presentation explores the connections between the theoretical cognitive foundations provided by Vygotsky and Piaget and the peer-led team learning model. Vygotsky studied the role of the instructor as students learn, and thus, his theories guided the development of the role of the workshop leaders. Piaget studied the process by which students construct knowledge; therefore, his theories guided the development of the project's curriculum materials.

Assessing the development of curved-arrow formalism mastery among first-semester organic chemistry PLTL and cPLTL students

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The cyber Peer-Led Team Learning (cPLTL) workshops are a synchronous online adaptation of the educational intervention PLTL, in which students, under the guidance of undergraduate peer facilitators, collaboratively solve problems in small groups. The purpose of this parallel convergent mixed methods study was to assess the impact of implementing cPLTL in an organic chemistry course on students' development of curved-arrow formalism skills. Although statistical analyses revealed comparable attendance rates, distributions of course grades, and achievement on an American Chemical Society First-semester Organic Chemistry Exam, plotting workshop grades by ABC and DFW grade groupings revealed that PLTL students earned more successful grades than cPLTL students (91% vs 77% ABC grades). A new curved-arrow formalism analytic framework was developed from both a review of the literature as well as through analysis of students' interview artifacts, using grounded theory. Utilization of this new curved-arrow formalism analytic framework for coding student interview artifacts revealed that cPLTL students were statistically less likely to successfully draw the product suggested by the curved-arrows than their PLTL classmates. Implications for faculty are suggested, such as optimizing graphical collaborative learning activities for online learners.

Peer-led team learning and Pratibha Varma-Nelson - irrepressible and resilient

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Peer-led team learning is a pedagogical initiative that is here to stay, with adoptions and adaptations in multiple institutional settings across the United States and internationally. This talk will present some of the research on PLTL and its adaptations, with a few asides about Pratibha's mentorship of me as a novice in chemical education.

**Attending to the subject**

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The benefits to learning from interpersonal interactions are older than Socrates. In the modern era, educators have embraced structured, peer-led methods as a popular high impact practice. This year's Pimentel Awardee deserves high marks for contributions to developing, promoting, supporting, and understanding these methods in widespread and diverse settings. The Peer-Led Study Group (PLSG) program at the University of Michigan was initiated by the department of chemistry in 1992, and was inspired by a graduate student initiative at the University of Wisconsin in the late 1970s. Now a college-wide program administered by the Science Learning Center, PLSGs are a supplemental instruction option, attracting thousands of students in our foundational STEM courses, and employing hundreds of peer facilitators each term. We recently strengthened the attachment of PLSGs to the chemistry department by creating a required, 1-credit "teaching chemistry" course for the 60-90 facilitators in the organic chemistry courses. We see these student leaders as members of an integrated instructional workforce that includes faculty and graduate student instructors. In this talk, I will describe a study in which we investigated whether or not this course was effective in intercepting and correcting facilitators' misunderstandings, preventing the propagation of subject matter errors in the PLSGs.

**Transferrable skills gained from experience asa peer-leader in a PLTL program: Reflections, applications, and long-term impacts on professional lives**

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Peer-led team learning has proven to be a great way to enhance the skills of workshop peer leaders in a multitude of academic programs. The role of a peer leader specifically is shown to impact content learning, presentation skills, teamwork skills, the appreciation for what it takes to be a teacher, group facilitation skills, as well as others. These skills learned from being a peer leader, however, do not terminate at the end of one's undergraduate program. These skills stay with individuals into the workplace in a variety of areas. Former peer leaders seem to value these experiences to the extent that many of them denote having been a peer leader on their LinkedIn profile. This study examines the value of being a peer leader as it relates to one's current position. This value was obtained by examining the transferable skills that former peer leaders recognize as important in their current positions. Semi-structured interviews were conducted with former peer leaders from varying disciplines, universities, ages, and years since being a peer leader. Thematic analyses of these interviews indicate that former peer leaders recognize leadership skills, the ability to cope with many challenges (including not having the right answer), collaboration/teamwork skills, self-confidence, and problem-solving skills all as being relevant and frequently used in their current work. The various constructs identified here show the value of being a peer leader post-graduation and inside one's profession. These data also lend themselves to a larger quantitative survey to be developed in the future.

Course-based undergraduate research via the CASPiE project: From idea inception to cross-institutional networks

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This presentation will provide an overview of the ways in which the foundational ideas of the CASPiE project, known as course-based undergraduate research or CURE, began with an idea that was on the leading edge of a new wave of such applications. The novel aspects of the PLTL work that were contributed by Dr. Varma­ Nelson were instrumental in linking this model to the authentic research that students would experience in an apprentice-style research experience.

Bringing peer learning into the laboratory and research setting

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A signature challenge of the CASPiE project was to support the social environment that is so essential in authentic research. As with almost all research groups, CASPiE research relied on having knowledgeable peers available to consult with the students doing the work. Two key elements of this were to determine how to integrate peer sessions into scheduled lab settings and also todevelop and refine workshop materials for PLTL use. This talk will present some examples of PLTL lab materials, including a description of their value in supporting student learning associated with questions such as reading a research paper, designing an experiment, and preparing for communication of results.

Award Address (George C. Pimentel Award in Chemical Education sponsored by Cengage Learning and the ACS Division of Chemical Education). Reflections on a non-traditional academic career: Lessons for the future

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This paper will explore the value of serendipitous collisions, accepting colleagues, exceptional mentors, candid friends, and partnerships with students in creating learning environments that work for them. Emphasis will be on lessons learned for the future in the context of some *very* commonly and often casually used jargon such as diversity, multiculturalism, active learning, inclusiveness, and so on. The critical role of change in faculty attitudes towards the new majority will conclude the presentation.