2018

Peer-led Team Learning Bridges the Learning Gap in a First-Year Engineering Technology Course

Chen Xu
CUNY New York City College of Technology

Ohbong Kwon
CUNY New York City College of Technology

Juanita C. But
CUNY New York City College of Technology

Benito Mendoza
CUNY New York City College of Technology

Janet Liou-Mark
CUNY New York City College of Technology

See next page for additional authors

2018 ASEE Mid-Atlantic Section Spring Conference: Washington, District of Columbia Apr 6

Peer-led Team Learning Bridges the Learning Gap in a First-Year Engineering Technology Course

Dr. Chen Xu, New York City College of Technology

Dr. Chen Xu is an Assistant Professor at Computer Engineering Technology department in New York City College of Technology. Her research interests are Engineering Education and Biomedical Optics.

Dr. Ohbong Kwon, New York City College of Technology

Ohbong Kwon is an Assistant Professor in the department of Computer Engineering Technology Department at New York City College of Technology of City University of New York. He received his B.S. and M.S. in the department of Electrical Engineering from Hanyang University in Korea and his M.S. and Ph.D. in the department of Electrical and Computer Engineering at the University of Florida. His area of research includes digital signal processing, digital design and control systems.

Dr. Juanita But, New York City College of Technology

Juanita But is Associate Professor of English at New York City College of technology, where she is the developmental reading coordinator. She is the Principal Investigator of READ (Reading Effectively Across the Disciplines), a program that was established in 2013 to improve student learning and disciplinary literacy across the curriculum. Her research and publications focus on reading pedagogy and multicultural literature.

Dr. Benito Mendoza, City University of New York

Benito Mendoza is an Assistant Professor of Computer Engineering at the New York City College of Technology (CITY TECH). Before he joined CITY TECH, he worked as a Postdoctoral Research Engineer at ExxonMobil Research and Engineering Company. His areas of interest include Multi-Agent Systems, Bio-Inspired Systems, Context and Situation Awareness, Cyber-Physical Systems, and Artificial Intelligence in Education and Intelligent Tutoring Systems. He holds a PhD. in Computer Science and Engineering from the University of South Carolina and an MSc in Artificial Intelligence and a BSc in Computer Science from the University of Veracruz, Mexico.

Dr. Janet Liou-Mark, New York City College of Technology, CUNY

Dr. Janet Liou-Mark is a Professor of Mathematics and the Director of the Honors Scholars Program at New York City College of Technology. She is also a Co-Principle Investigator on three National Science Foundation (NSF) grants: Math Science Partnership (MSP) grant, Research Experience for Undergraduate (REU) grant, and Improving Undergraduate STEM Education (IUSE): Pathways into Geoscience grant and a Co- Principle Investigator on a Department of Education Minority Science and Engineering Improvement Program (MSEIP) grant. Dr. Liou-Mark has organized several STEM-related conferences and national conference sessions on diversifying the STEM workforce. She continues to speak at conferences and conduct workshops on best practices for underrepresented minorities in STEM. Dr. Liou-Mark is selected as the 2017-2018 Scholar on Campus. She was awarded the 2017 Best of New York Award for her contributions to City Tech. Her research interest in the implementation of the Peer-Led Team Learning (PLTL) instructional model in mathematics has won her the 2011 CUNY Chancellor's Award for Excellence in Undergraduate Mathematics Instruction and the Mathematical Association of America Metro New York Section 2014 Award for Distinguished Teaching of Mathematics. She is the director of the Peer-Led Team Learning Leadership Program at City Tech, and she has trained over 175 underrepresented minority students majoring in a STEM discipline to be effective Peer Leaders. Moreover, Dr. Liou-Mark has personally mentored over 200 STEM students where a third are continuing or obtaining advanced STEM degrees. She organizes and speaks at women conferences in Malawi, Africa, and she is also building libraries for the schools and communities in the Malawian villages.

Prof. Robert Ostrom

Robert Ostrom is an assistant professor in the Department of English at New York City College of Technology, CUNY and adjunct professor at Columbia University's School of the Arts.

Peer-led Team Learning Bridges the Learning Gap in a First-Year Engineering Technology Course

Chen Xu[1], Ohbong Kwon[1], Robert Ostrom[2], Juanita But[2], Benito Mendoza[1], Janet Liou-Mark[3]

1 Department of Computer Engineering Technology, New York City College of Technology, CUNY, Brooklyn, New York
2 Department of English, New York City College of Technology, CUNY, Brooklyn, New York
3 Department of Mathematics, New York City College of Technology, CUNY, Brooklyn, New York

Abstract

Electrical Circuits (EMT 1150) is a first-year engineering gateway course for Electromechanical Engineering Technology (EMT) associate degree students. It is a five-credit course with a combined lecture and laboratory components. EMT 1150 has always been identified as one of the most challenging courses in the major with high failing rate. From the instructors' perspective, the reason for the high failure rates is due to first-year students having to learn the language of engineering in a very short time; simultaneously, they need to develop good critical thinking and problem-solving skills. In this paper, the preliminary results of a new pedagogical approach that incorporates Peer-Led Team Learning (PLTL) and discipline-specific literacy strategies to improve student learning will be presented. The proposed approach consists in a restructure of the course material and the introduction of recitation workshop integrated with the PLTL strategies. The new course design was piloted in a semester and the results were compared with a controlled section using a uniform final exam at the end of the semester. On average, the piloted PLTL section performed approximately 15% higher than the non-PLTL sections.

Keywords

Engineering Education, Peer-led Team Learning, Electrical Circuits, First-year Student

1. Introduction

New York City College of Technology (City Tech) of The City University of New York (CUNY), is the largest four-year public college of technology in the Northeast and a national model for technological education. City Tech has an enrollment of more than 17,000 students in 26 baccalaureate and 27 associate degree programs. The college has an open admission policy and serves a culturally and academically diverse student population. 33% of students are Hispanic, 30% of students are Black (non-Hispanic), 20% of students are Asian, and 11% of students are white (non-Hispanic) [1]. In the past five years, the average annual enrollment of first-time freshmen was around 3,300. Each year, many of our entering freshmen need to take developmental English and/or Math courses. Even after exiting developmental courses, some students still lack the college readiness and academic skills to succeed in courses in their majors.

Electrical Circuits (EMT 1150) is a five-credit foundational engineering course for freshman students majoring in the AAS degree program in Electromechanical Engineering Technology (EMT) offered by the Computer Engineering Technology (CET) department at New York City College of Technology. This course includes both lecture and laboratory components. The lecture portion of the course introduces the physical basis and mathematical models of electrical components and circuits. Topics include Ohm's Law, Watt's Law, resistance, series, parallel, and series-parallel circuits, network theorems, Thevenin equivalent circuits, capacitive and inductive circuits, and sinusoidal ac inputs. The lab portion of the course is performed on a breadboard using the digital multi-meter, oscilloscope and function generator. According to the data from City Tech's Assessment and Institutional Research, the average enrollment for EMT1150 in the past ten consecutive semesters was around 144 students per semester. However, the percentage of students passing the course with a D or better was 73%, and the percentage of students passing the course with a C or better was only about 64%. [2] These results show that approximately a third of the students either failed or withdrew from the course. Because EMT1150 is the prerequisite course for most courses in the Associate degree program in EMT, students who do not pass this course either retake the course, transfer to other departments, or withdraw from the college.

We have examined the causes for the high failure rates in this course. From the instructor's view point, this course is the first course that introduces the formal engineering language to freshman students. The engineering language emphasizes the use of the scientific method and logic reasoning to express the problem. Just like learning any language, students usually experience a steep learning curve at the beginning of the course. This is particularly evident in EMT1150, since the course involves an array of technical concepts and difficult vocabulary. Moreover, EMT1150 also requires good critical thinking and problem solving skills that first-year students may lack. In this paper, we present the preliminary results of a new pedagogical approach applied to EMT1150 that incorporates Peer-Led Team Learning (PLTL) and discipline-specific literacy strategies.

2. Implementation of Peer-Led Team Learning strategy

Peer-led team learning (PLTL) is a model of teaching undergraduate science, math, and engineering courses that introduces peer-led workshops as an integral part of a course, where the peer-leaders meet with small groups of six to ten students each week, for one to two hours, to discuss, debate, and engage in problem solving related to the course material.[3] It was originated by Professor Victor Strozak at the City College of New York in the early 1990s as part of an effort to address the low success rate of students in General Chemistry. In 2003, Professor Janet Liou-Mark at New York City College of Technology introduced PLTL model to Mathematics courses. Her results showed that the pass rates (ABC grades) for workshop participants in Precalculus courses were 30% higher than the non-participants with the same instructor and the withdrawal rates were 7.5% lower among workshop participants than for non-participants. Furthermore, the participants reported that the engagement with peer leaders and with other workshop participants created an inviting and encouraging environment to work on mathematics problem sets.[4] She further pointed out that six components, such as 1). workshops are integral to the course, 2). peer leaders are trained and supervised, 3). a faculty is involved with the workshops, 4). materials are appropriately challenging, 5). suitable time and space are designated for workshop sessions, and 6). there is institutional support, are critical to successfully cultivate the execution of PLTL in different courses. [5]

To implement PLTL model to EMT1150, our team started the preparation in Fall 2016. Seven peer-leaders who were motivated students and completed this course with B+ and above grades, were recruited and recommended to take a weekly seminar course (Peer Leader Training in Mathematics, MEDU 2901).). This seminar helped them learn to facilitate collaborative team work, develop ethical principles, build vital skills to communicate effectively, and learn strategies to manage and effect attitudinal change. Meanwhile, we recognized that the current structure of EMT1150 was not meeting the needs of our students. In the current format, the instructor either uses the whiteboard or power point presentation to introduce new theories and present the examples during the lecture. Students can have some time to practice certain examples by themselves, but most of time, they are in the passive leaning mode. Physiology and cognitive research show that category learning and interleaving is more effective than passive learning only.[6] Especially for this class, students need to reinforce some important concepts repeatedly, such as Ohm's law, series and parallel structure. They need to have adequate practice to learn how to use those rules under different circumstances. To address these needs, we condensed the lecture materials to two hours weekly, and allow the other two lecture hours to be used as PLTL recitation workshop, which is integrated to the course and mandatory to each student. The PLTL workshop can provide students with additional time to practice the theory, and allow them to learn from their mistakes in a supportive environment. Cognitive research show that trying and failing can improve later recall of material.[7] We also designed scaffolding recitation modules corresponding to each chapter. Each module started from reviewing simple concepts, then applying those concepts to simple problems and more challenging questions. Some common mistakes which students tend to make were broken down to detailed steps to facilitate understanding.

Another problem was the lack of synchronization between the lecture and lab section. Currently, students need to register for EMT1150 lecture and lab separately in online registration system (CUNYfirst) and very often the lab and lecture sections they enroll in are taught by different instructors. The structure of current lab material often requires students to do certain experiments even before they learn those materials in the lecture. With the administrative support from the CET department, we piloted a learning community that linked the lecture and the lab together to be taught by the same instructor. As a result, some supplemental lab materials were developed to target specific problems observed in the lectures and homework.

In our studies, we found that reading and literacy skills are important to help students learn the engineering language.[8] However, many first-year EMT students do not demonstrate sufficient literacy skills and motivation to navigate the engineering texts and to learn effectively through reading. To tackle this problem, instructors worked with English/Reading faculty in the Reading Effectively Across the Disciplines (READ) program to design and implement discipline-specific literacy strategies. These strategies were integrated into the weekly reading practice with peer-leaders to facilitate reading-to-learn, which is essential to improving students' critical thinking skills and disciplinary literacy.

3. Results and conclusion

In Fall 2017, we launched one pilot section (n =15) implemented with restructured EMT1150 materials. Meanwhile, another EMT1150 section that was taught by the same instructor was used as a controlled section (n = 15). Throughout the semester, the pilot section implemented PLTL recitation workshops and reading practices; the labs and lectures of pilot section were synchronized

under the guidance of the same instructor. The controlled section covered the exactly same materials, but without the PLTL workshop and synchronized lab. At the end of semester, a uniform exam accommodated to ABET requirements was given to all sections. As shown in Figure 1, the average score of the PLTL section was 78.2, and the average score of non-PLTL section was 67.8. The improvement of student performance in the PLTL section was about 15%, compared with the non-PLTL section.

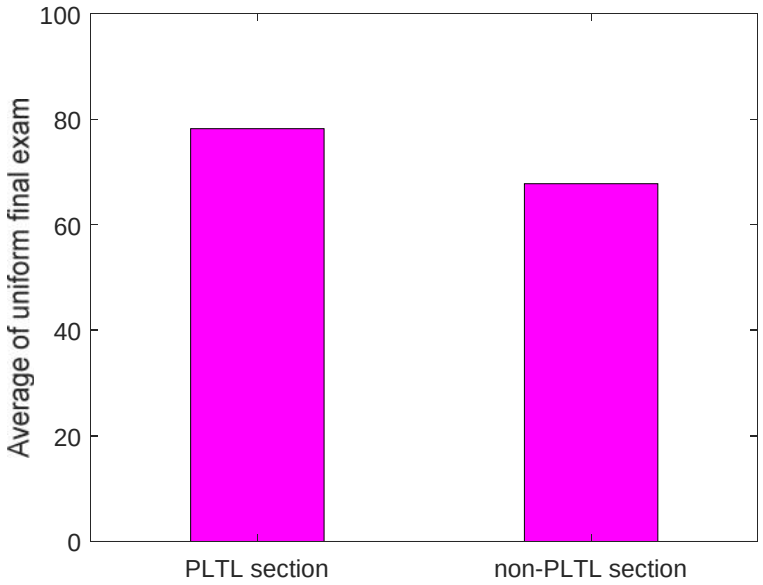

Figure 1. The comparison of the average of uniform final exam

In conclusion, our results suggest that integrating PLTL recitation workshop into first-year Electrical Circuit course will help our students bridge the learning gap. We plan to collect more information for future improvements and expand this practice to other EMT150 sections.

Acknowledgement

This work was supported by STEM Faculty Development Grant Funded by Accelerated Study in Associate Programs (ASAP) of the City University of New York. We are grateful to have these dedicated peer-leaders. They are Leonardo Chiang, Janelynnel Ladaban, Elizabeth Ferreira Pichardo, Galib Rahman, Samiha Riham, Manjit Singh, and Chukwudi Udoka. We are also grateful to Dr. Sunghoon Jang, Chair of Computer Engineering Technology, Julia Jordan, Director of Faculty Commons, Associate Provost Pamela Brown, and Provost Bonne August for their continuous support.

References

1. Fact sheet of City Tech, http://www.citytech.cuny.edu/about-us/docs/facts.pdf

2. http://air.citytech.cuny.edu/GradeDistribution/

3. D. Gosser, and V. Roth, "The Workshop Chemistry Project: Peer-led Team Learning," Journal of Chemical Education, *75* (2), 185 (1998)

4. J. Liou-Mark, A. Dreyfuss, L. Younge, "The implementation of peer assisted learning workshops in precalculus: an approach to increasing student success", *Mathematics and Computer Education*, 44(3), 249-259 (2010)

5. J. Liou-Mark, A. Dreyfuss, S. Han, L. Yuen-Lau, K. Yu, "Aim for success: peer-led team learning supports first-year transition to college-level mathematics," *Journal of Learning Development in Higher Education, Special Edition: Academic Peer Learning*, 1-24 (*2015*)

6. S. Noh, V. Yan, R. Bjork, W. Maddox, "Optimal sequencing during category learning: Testing a dual-learning systems perspective," *Cognition, 155,* 23-29 (2016).

7. V. Yan, Y. Yu, Y., M. Garcia, R. Bjork, "Why does trying, and failing, to predict to-be-learned responses enhance later recall of those responses?" *Memory & Cognition, 42,* 1373-1383 (2014)

8. O. Kwon, C. Xu, J. But, "Reading matters in First Year Electrical Circuits Course," FYEE conference paper, 2016, W1A

Author Information

Dr. Chen Xu is an assistant professor in the Department of Computer Engineering Technology at New York City College of Technology, CUNY. Her research interests are Engineering Education and Biomedical Optics.

Dr. Ohbong Kwon is an assistant professor in the Department of Computer Engineering Technology at New York City College of Technology, CUNY. His research interests include Engineering Education, Digital Signal Processing and Digital Design.

Mr. Robert Ostrom is an assistant professor in the Department of English at New York City College of Technology, CUNY.

Dr. Juanita But is an associate professor in the Department of English at New York City College of Technology, CUNY.

Dr. Benito Mendoza is an assistant professor in the Department of Computer Engineering Technology at New York City College of Technology, CUNY. His research interests include Multi-agent Systems and Computer Science and Engineering Education.

Dr. Janet Liou-Mark is a professor in the Department of Mathematics at New York City College of Technology, CUNY. Her research is in developing models and educational programs that support underrepresented minority students in STEM.