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The Effects of Peer-Led Workshops in a Statics Course

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Melanie Villatoro is an Assistant Professor in the Department of Construction Management and Civil Engineering Technology at NYC College of Technology. She teaches a variety of courses in the civil engineering major including statics, strength of materials, concrete, steel, soil mechanics, and foundations. Melanie's approach to teaching builds on developing rapport with her students. She is highly effective in the classroom and as an advisor and mentor. She is passionate about student retention and performance, as well as STEM Outreach from the elementary to the high school level.

Karla Karolin Peña, Student

Karla Peña comes from Santo Domingo, Dominican Republic. She moved to the United States when she was 14 years old and continued her high school education at Bronx International High School where she eventually graduated from. Karla graduated from high school with honors after being part of the chosen students to take AP courses based on grades and being an active member of the student government. Even though Karla wants to get a bachelor's degrees, she is currently working on her associates degree in Civil Engineering at New York City College of Technology. Karla recently joined the Peer-Led Team Learning organization at her college. The PLTL program has showed her how satisfying and important it is to share your knowledge with peers on a similar path as you. Besides helping others succeed in their college courses, the PLTL program has made her a better individual and student. After graduating with her associates degree, Karla plans to pursue a field inspector position in order to obtain experience for her future career.

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.

The Effects of Peer-Led Workshops in a Statics Course

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Abstract

According to the Bureau of Labor Statistics, an 8% increase in employment for civil engineers is expected in the next decade.[1] To assist in attracting more undergraduates to pursue a degree in Civil Engineering Technology, New York City College of Technology has implemented an instructional strategy in one of the main gatekeeper courses. Statics has been identified as a course where undergraduates either decide to retain in their Civil Engineering Technology major or transfer out to another one. To provide more support for undergraduates taking this course, the Peer-Led Team Learning (PLTL) strategy was adopted. This study compared the final grade distribution of the Statics course in three categories: no PLTL, non-mandatory PLTL, and mandatory PLTL. These categories reflect the time periods of the Statics course where PLTL was not offered at all, when it was an optional support program, and when it officially became part of the curriculum. After analyzing the final grade distribution, results showed that the ABC pass rates of the mandatory PLTL sections were approximately 20% higher when compared to both the no PLTL and non-mandatory PLTL sections. Moreover, the withdrawal rates were approximately 10% lower for the mandatory PLTL sections when compared to the rates of the other two sections.

Keywords

Statics, Peer-Led Team Learning, Collaborative Learning.

Introduction

The fields of Science, Technology, Engineering, and Math (STEM) have been identified as fields that require a greater number of STEM proficient employees. Employment of engineers is projected to grow 4% from 2014 to 2024, adding about 65,000 new jobs.[2] The demand for STEM professionals has highlighted the fact that there is a shortage of them.[3,4] The current enrollment trends for STEM majors indicate that there will be a shortage of qualified individuals to fill the projected growth. According to the Bureau of Labor Statistics an 8% increase in employment for civil engineers alone is expected in the following 10 years.[1] In 2016, of 1,024,187 associate degrees earned, only 5,004 were in engineering.[5] The number of students pursuing STEM degrees needs to be increased in order to reduce the STEM labor force shortage.[6] Additionally, the enrollment and graduation rates in civil engineering programs must increase significantly to meet the projected demand for civil engineers. In order to minimize the shortage, the education system for STEM majors needs to be analyzed.[7]

Peer -Led Team Learning

An instructional method that has been identified as a best practice to help students get through their STEM major courses is the Peer-led Team Learning (PLTL) instructional design. PLTL consists of students working in small groups under the guidance of a trained peer leader during a

one-hour weekly workshop. The role of the peer leader is to implement various techniques in order to engage the entire group without providing students with the solutions. This model provides a healthy and engaging learning environment for students because they are working with peers that have already completed the course who understand and have experienced the learning curve.[8]

PLTL was originally created in order to increase passing rates, lower failure rates, and to retain students in STEM majors.[9] PLTL has been shown to increase the passing rates and decrease the withdrawal rates in STEM fields. Wilson et al, cited a 60% increase in ABC grades after implementing PLTL into STEM courses.[10] The results of a study on students in an introductory biology course indicated that retention in the class was higher for students that attended the PLTL sections, and those who did not were likely to end up withdrawing from the course. The percentage of students earning D's was 40% and PLTL reduced it to 15%.[8]

Components of PLTL that have been recognized as contributory to its success include small group settings, active learning, and the formation of mentor/mentee relationships. PLTL has been proven to provide a greater sense of belonging for students that attend the workshops.[11] It is believed that the creation of small learning communities between students affects them positively meaning they might have a higher chance of getting a grade of A, B, C, or D.[10] Students are able to master the material when they have PLTL sections, it allows them to retain the information because they were actively engaged in solving the problem.[12] Implementation of active learning through PLTL has improved retentions rates by 15%.[13]

Peer-Led Team Learning in Statics

The Construction Management and Civil Engineering Technology (CMCE) department offers associate degrees in Civil Engineering Technology and Construction Management Technology and a bachelor degree in Construction Engineering Technology. Every student enrolled in the department is required to take the design course sequence, Statics, Strength of Materials, Steel Design and Concrete Design. Statics is the first course of this sequence and is identified as a gatekeeper course. Students must earn a minimum grade of a C to advance to the next course in the sequence. The statics course provides an introduction to the concepts of force, equilibrium, section properties, load pattern distribution and equilibrium. A students' performance in statics is indicative of their success in the curriculum; without satisfactorily passing the course, it is unlikely the student will be retained in the major. Poor grade distributions and low retention rates for first-time, full-time, degree-seeking freshman in the department identified a need for re-evaluating the Statics course. PLTL, as an evidence-based proven practice, was the chosen method of intervention for Statics.

Participants

The participants for this study were taken from the Statics courses offered during the Spring 2009 to Fall 2016 semesters. They were all first-year undergraduate students majoring in Construction Management and Civil Engineering Technology. The students were arranged into three distinct cohorts based on their involvement in PLTL: 1) No PLTL, 2) Non-mandatory PLTL, and 3) Mandatory PLTL. Using the earlier semesters as the comparison group for this study (Spring 2009-

Fall 2010), a total of 397 was placed into Cohort I: No PLTL. The average enrollment for each semester was about 99 students. Soon after, PLTL workshops were introduced for the next five semesters (Spring 2011-Spring 2013), and it provided the students with an optional supplemental support for Statics. The Cohort 2: Non-mandatory PLTL group had 433 students, and there were approximately 87 students enrolled in the course per semester. For the following seven semesters (Fall 2013-Fall 2016), PLTL was made a mandatory component for the course. A total of 566 students were in the Cohort 3: Mandatory PLTL group, and the average enrollment per semester was 81 students. The total number of participants for all three cohorts was 1396. Table 1 details the total number of participants by cohort and semester.

Methodology

For all three cohorts (No PLTL, Non-mandatory PLTL, and Mandatory PLTL), the final grade distribution for the Statics course were recorded and organized into five categories: 1) % pass D or better, 2) % pass C or better, 3) % did not pass (including withdraws, failures, and incomplete grades), 4) % Fail, and 5) % withdraw. Descriptive statistics were used to summarize the data.

Additionally, a one-way Analysis of Variance (ANOVA) was conducted to compare the means of the three cohorts in their pass rates, failure rates, and withdrawal rates. A Tukey t-test was used as a follow up if the analysis showed statistically significant mean differences.

Results

The means and standard deviations for the number of participants and the grade distributions were calculated for the three cohorts (see Figures 1-4). Cohort 3: Mandatory PLTL showed higher means in % Pass D or Better ($\bar{X}$=78.9) and % Pass C or Better ($\bar{X}$=75.7) than Cohort 1: No PLTL ($\bar{X}$=66.7 and $\bar{X}$=56.4, respectively) and Cohort 2: Non-mandatory PLTL ($\bar{X}$=60.5 and $\bar{X}$=53.7, respectively). Moreover Cohort 3: Mandatory PLTL showed lower means in % Did Not Pass ($\bar{X}$=21.1) and %Withdrew rates ($\bar{X}$=12.5) than the two other cohorts. In terms of % Fail, all three cohorts were at the 8.6-8.9 percent range. Table 1 summarizes the results.

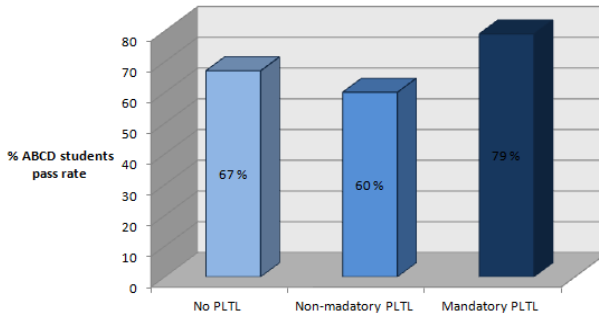

Figure 1: % Pass D or Better in statics by PLTL participation

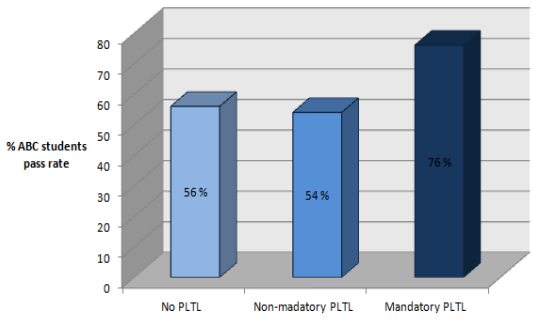

Figure 2: % Pass C or Better in statics by PLTL participation

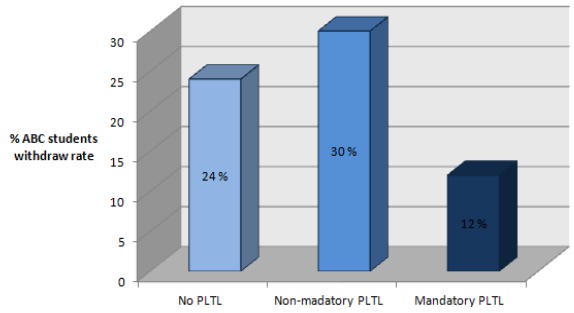

Figure 3: % Withdrew in statics by PLTL participation

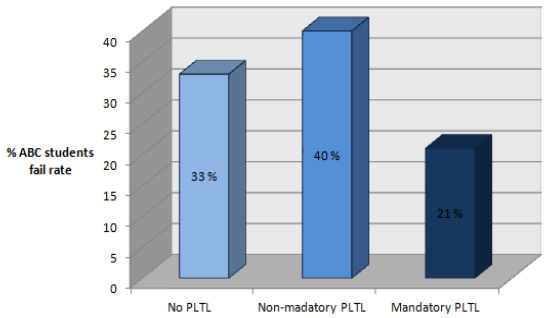

Figure 4: % Fail in statics by PLTL participation

Table 1: Mean and standard deviation of the number of participants and the grade distribution by cohort and semester

	N (Total Enrollment)	% Pass D or Better	% Pass C or Better	% Did Not Pass (Fail, Withdrew, Incomplete)	% Fail	% Withdrew
Cohort 1: No PLTL						
Spring 2009	85	68.2	52.9	31.8	5.9	25.9
Fall 2009	118	68.6	61	31.4	11.9	17.8
Spring 2010	86	69.8	61.6	30.2	3.5	24.4
Fall 2010	108	60.2	50	39.8	13	26
Mean (SD)	99.3 (16.4)	66.7 (4.4)	56.4 (5.8)	33.3 (4.4)	8.6 (4.6)	23.5 (3.9)
Cohort 2: Non-Mandatory PLTL						
Spring 2011	87	55.2	40.2	44.8	8	35.6
Fall 2011	116	56.9	48.3	43.1	6.9	36.2
Spring 2012	82	54.9	52.4	45.1	12.2	33
Fall 2012	87	63.2	58.6	36.8	9.2	27.5
Spring 2013	61	72.1	68.9	27.9	8.2	19.7
Mean (SD)	86.6 (19.6)	60.5 (6.5)	53.7 (9.7)	39.5 (6.5)	8.9 (1.8)	30.4 (6.2)
Cohort 3: Mandatory PLTL						
Fall 2013	46	73.9	71.7	26.1	10.9	15.2
Spring 2014	60	76.7	71.7	23.3	8.3	15
Fall 2014	73	82.2	79.5	17.8	1.4	16.5
Spring 2015	84	90.5	84.5	9.5	3.6	6
Fall 2015	87	85.1	78.2	14.9	5.7	9.2
Spring 2016	96	74	74	26	19.8	6.3
Fall 2016	120	70	70	30	10.8	19.1
Mean (SD)	80.9 (24.2)	78.9 (7.3)	75.7 (5.3)	21.1 (7.3)	8.6 (6.1)	12.5 (5.2)

The results from a one-way ANOVA test and followed up by a Tukey test, if needed, are summarized by the following grade distribution: % Pass D or Better, % Pass C or Better, % Did Not Pass (including withdraws, failures, and incomplete grades), % Fail, and % Withdraw.

% Pass D or Better: Results from a one-way ANOVA showed statistically significant mean differences among the three groups in % Pass D or Better ($F(2,13) = 11.641$, $p<.001$). As a follow up, a Tukey test showed statistically significant mean differences between Cohort 1: No PLTL and Cohort 3: Mandatory PLTL ($t = 2.262$, $p<.01$) and between Cohort 2: Non-mandatory PLTL and Cohort 3: Mandatory PLTL ($t = 2.262$, $p<0.001$).

% Pass C or Better: Results from a one-way ANOVA showed statistically significant mean differences among the three groups in % Pass C or Better ($F(2,13) = 15.180$, $p<.001$). A Tukey test showed statistically significance mean difference between Cohort 1: No PLTL and Cohort 3: Mandatory PLTL ($t = 2.450$, $p<0.001$) and between Cohort 2: Non-mandatory PLTL and Cohort 3: Mandatory PLTL ($t = 2.570$, $p<0.01$).

% Withdraw: Results from a one-way ANOVA showed statistically significant mean differences among the three groups in the withdraw grades ($F(2,13) = 15.850$, $p<.001$) groups. A Tukey test showed statistically significance mean difference between Cohort 1: No PLTL and Cohort 3: Mandatory PLTL ($t = 2.310$, $p<.01$) and between Cohort 2: Non-mandatory PLTL and Cohort 3: Mandatory PLTL ($t = 2.364$, $p<0.001$).

% Fail: There were no statistically significant mean differences in the failure grades ($F(2,13) = 0.010$, $p = 0.993$) among the three groups.

Conclusion

Having academic support systems in place to support first-year students majoring in Construction Management and Civil Engineering Technology may help to increase the retention rates in foundational courses such as Statics. Many of these students are adjusting to college life, and they may not have the background skills necessary to succeed in their prerequisite courses. An intervention such as PLTL where students can have meaningful discussions facilitated by their own peers, may help students process the content knowledge in a more meaningful and deeper way. This study has shown students who participate in PLTL workshops tend to have higher pass rates and lower withdrawal rates. These positive results are consistent in past studies that use the PLTL instructional model in other STEM courses.[14] If higher education institutions want to attract, retain, and graduate more students in the Construction Management and Civil Engineering Technology, PLTL may be an effective intervention that will support first-year students.

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Karla Peña

Karla Peña moved from the Dominican Republic to the United States at age 14. She attended Bronx International High School where she graduated with honors and was an active member of the student government. Karla is currently pursuing her associates degree in Civil Engineering Technology at New York City College of Technology and plans to further advance her academic

career towards a bachelor degree and beyond. Karla is a Peer Leader and has participated in the CUNY Research Scholars Program.

Janet Liou-Mark

Janet Liou-Mark is a Full Professor in the Department of Mathematics at New York City College of Technology. In 2011, she was awarded the CUNY Chancellor's Award for Excellence in Undergraduate Mathematics Instruction for her work on "*The Implementation and the Effects of the Peer-Led Team Learning (PLTL) Model in Mathematics*." In 2014, Dr. Liou-Mark was awarded the Mathematical Association of America Metro New York Section Award for Distinguished Teaching of Mathematics.