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CHEMISTRY STUDENTS' ATTITUDES ABOUT PEER-LED TEAM LEARNING WORKSHOPS: COMPARISON TO THE SIX CRITICAL COMPONENTS

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Peer-Led Team Learning (PLTL) is a "curricular structure" (Gosser and Roth, 1998) that was developed in the early 1990s to improve college students' pass rates in chemistry courses. In addition to the traditional lectures by faculty, a course's components includes a *workshop* which is scheduled weekly and led by a Peer Leader, a student who has previously taken the course and performed well. The PLTL model is characterized by six "critical components" which were developed through extensive evaluations (Gafney, 2001a). These "Six Critical Components" are:

1. Peer-Led Workshop is integral to the course.
2. Instructors (faculty & teachers) are involved in the selection of materials, training, and supervision of peer leaders, and they monitor the progress of Workshops.
3. Peer leaders are selected, trained, and supervised to be skilled in group work as facilitators.
4. Workshop materials are appropriately challenging, directly related to course methods of assessment, designed for small group work.
5. Workshops are scheduled and held once a week for two hours, contain six to eight students per group, in space suitable for small-group activities.
6. The Peer-Led Team Learning program is supported by the department and the institution with funds, course status, and other support so that the program has the opportunity to be adopted across courses and disciplines.

Evaluations of chemistry courses using PLTL at various colleges have consistently demonstrated that students receive A, B, or C grades at higher rates than those students who have not had a peer-led workshop (e.g., Hockings, DeAngelis, and Frey, 2008; Lyon and Lagowsky, 2008; Gafney, 2001a). Students are also less likely to withdraw from introductory courses (Gafney, 2001a) and more likely to persist to higher-level courses (Wamser, 2006).

While tracking students' performance and perseverance is important to determine the effect of the incorporation of workshops in courses, little has been published on students' attitudes toward workshops: How do students feel about PLTL workshops? One method of examining this question is through a questionnaire developed by Gafney (2001b). This paper will present the results of a three-

semester study using this questionnaire on how students view workshop in their introductory chemistry courses.

Context of the Study

Since the mid-1990's a PLTL workshop program has been incorporated in a two-semester General Chemistry course at the City College of New York, City University of New York (CUNY), which has had an enrollment of between 600-800 students each in Fall and Spring semesters. For many students the course is a requirement for their majors in science or engineering and a pre-requisite for higher-level courses. When students sign up for the course, they are assigned a specific time for lecture, laboratory, and workshop, a mandatory component of the course. Each semester, there are six faculty members who teach the course – four for General Chemistry I, and two for General Chemistry II (not all students are required to take both semesters). The peer-led workshop sessions are separate sessions from both the lecture and laboratory sessions. Workshop groups are composed of six to twenty students guided by the Peer Leader with approximately 60 workshops held each semester during the day and evening.

Method

The student survey, designed by Gafney (2001b), was used to evaluate students' satisfaction with the workshop component of the course. The survey can be found in Appendix III in the *PLTL Guidebook* (Gosser, Cracolice, Kampmeier, Roth, Strozak, & Varma-Nelson, 2001). There are 36 questions, using a Likert scale (1= strongly disagree to 5= strongly agree) for responses, with the exception of a question regarding time spent studying.

The survey was administered during three different semesters: Spring 2008, Fall 2008, and Spring 2009 in General Chemistry I & II sections as shown in Table I. Students were asked to fill out the survey in their workshop session during the third week prior to the end of the semester. The survey forms were distributed by the Peer Leaders, completed by the students anonymously, and returned to the Peer Leaders who left the forms in a collection box in the department office. The number of respondents for each semester is presented in Table 1.

Table 1. Number of Respondents by Semester

	Number of respondents in General Chemistry I	Number of workshops with respondents	Average number of students per workshop (toward end of semester)	Number of respondents in General Chemistry II	Number of workshops with respondents	Average number of students per workshop (toward end of semester)	Total number of respondents
Spring 2008	148	23	7	177	18	10	325
Fall 2008	299	43	7	148	18	8	447
Spring 2009	308	42	7	165	17	9	473

Data Analysis

Results presented in Tables 2 – 8 present the means for responses to the Likert Scaled items. To provide a framework for the results, the questions were grouped by the Six Critical Components.

Since workshops are a mandatory component of the General Chemistry courses, participation counted toward students' grades. Questions #1, 2, 11, and 17 in Table 2 connect to the idea of workshop integrated with lecture. The ratings suggest affirmation that students feel that the workshops help them to do well on tests and the workshop materials are aligned with lecture content. Question #17 points to the importance of integrating workshop as a course component because students report that they are "uncomfortable asking questions in lecture." This is noteworthy in comparison to Question #10 in Table 3, where most students agreed that they feel comfortable asking questions in workshop.

Table 2. Responses to Questions Related to Critical Component #1

Critical Component #1: Workshop is integral to the course*							
Survey Question Number	**Statement**	**General Chemistry I**			**General Chemistry II**		
		Spring 2008	**Fall 2008**	**Spring 2009**	**Spring 2008**	**Fall 2008**	**Spring 2009**
1	The workshops are closely related to the material taught in the lectures.	4.00	4.40	4.49	4.10	4.35	4.49
2	Workshops help me do better in tests.	4.14	4.10	4.30	3.58	3.75	4.07
11	The lecture encourages us to participate in the workshops.	3.75	3.70	4.03	3.76	4.00	4.12
17	I am uncomfortable asking questions in the lecture.	2.83	3.10	4.24	2.84	3.20	3.99

*Survey scale with 1= strongly disagree and 5= strongly agree

The selection and training of peer leaders may be judged as reflected through students' sense of a useful workshop. Questions #12 and 14 in Table 3 speak to the environment of workshop, and the need for training. The Peer Leaders were trained to see themselves not as teachers but as guides, and this position confuses students who attend workshops with the expectation of wanting to know the right answers. When the Peer Leader does not provide this immediate request, students usually feel frustrated. However, this frustration is intentional and by design to challenge students to work collaboratively on problem sets. Question #30 suggests that the Peer Leader may feel the need to explain a concept that students do not grasp, in an effort to help a student. Similarly with Question #31, the Peer Leader may feel there is no alternative except to answer a question directly, if no one in the group can explain the problem. The lower mean values in Question #33 confirmed students were not working alone. Questions #35 and #36 pointed to possible activities to support learning, and the results showed that hands-on activities (e.g., modeling, use of manipulatives), and technology or computer simulations were not often used in workshop.

Table 3. Responses to Questions Related to Critical Component #3

Critical Component #3: Peer Leaders are trained and supervised							
Survey Question Number	Statement	General Chemistry I			General Chemistry II		
		Spring 2008	Fall 2008	Spring 2009	Spring 2008	Fall 2008	Spring 2009
3	Interacting with the workshop leader increases my understanding.	4.34	4.30	4.39	3.78	3.95	4.20
7	I regularly explain problems to other students in the workshop.	3.56	3.60	3.71	3.25	3.60	3.41
8	Interacting with the other group members increases my understanding.	4.24	4.20	4.21	3.83	4.05	4.10
10	In the workshop I am comfortable asking questions when I do not understand something.	4.33	4.40	4.49	3.99	4.10	4.44
12	The workshops are often dominated by one or two students.	2.88	2.90	2.84	2.68	2.80	2.56
14	Students who are uninterested or unmotivated make it difficult for others to benefit from the workshops.	4.34	4.30	4.39	3.78	3.95	4.20
15	I feel comfortable with the workshop leader.	3.56	3.60	3.71	3.25	3.60	3.41
16	The workshop leader is well prepared.	4.24	4.20	4.21	3.83	4.05	4.10
30	The workshop leader presents ideas and methods.	3.97	4.10	4.09	3.71	3.75	3.88
31	The leader responds to student questions.	4.30	4.40	4.36	4.11	4.20	4.35
32	Students work on problems in pairs or small groups.	4.12	4.30	4.14	4.07	4.15	4.15
33	Students work on problems alone.	3.23	2.90	2.94	2.99	3.15	3.06
34	Students present solutions.	4.01	4.20	4.23	3.58	3.95	3.79
35	Hands-on activities.	3.50	3.40	3.66	3.12	3.70	3.31
36	Technology and computer simulations.	1.86	1.90	2.09	1.79	1.95	1.86

*Survey scale with 1= strongly disagree and 5= strongly agree

Questions #4, 5, and #23-29 in Table 4 directly address workshop materials: Are they helpful in preparation for exams (#4), well-connected with lecture (#23), developed to review fundamentals (#25), useful for group work (#26), motivational (#27), helpful for individual study (#28), and useful for

reinforcing concepts (#29)? The workshop problems are intended to review and reinforce the concepts learned in lectures. They are designed to be challenging, to be suitable for small group work and to encourage active learning. Instructors and sometimes the Peer Leaders have devoted time to preparing materials. The results presented in Table 4 suggest that the materials, while adequate, could be more challenging (Questions #5 and #24).

Table 4. Responses to Questions Related to Critical Component #4

Critical Component #4: Materials are challenging							
Survey Question Number	**Statement**	**General Chemistry I**			**General Chemistry II**		
		Spring 2008	**Fall 2008**	**Spring 2009**	**Spring 2008**	**Fall 2008**	**Spring 2009**
4	The workshop materials are helpful preparation for exams.	4.14	4.00	4.28	3.59	3.85	4.15
5	The workshop materials are more challenging than most textbook problems.	3.33	3.30	3.24	3.01	3.25	3.12
23	The materials are well connected with the lecture.	3.96	4.10	4.07	3.86	4.05	4.23
24	The materials are challenging.	3.63	3.70	3.85	3.55	4.10	3.74
25	The materials are developed to review fundamentals.	3.86	3.90	4.09	3.70	3.85	4.02
26	The materials are useful for group work.	3.82	4.10	4.16	3.75	4.00	4.01
27	The materials are motivational.	3.63	3.80	3.97	3.59	3.80	3.89
28	The materials are helpful for individual study.	3.78	3.90	4.04	3.74	4.00	4.08
29	The materials are useful for reinforcing concepts.	3.96	4.10	4.18	3.82	4.00	4.2

*Survey scale with 1= strongly disagree and 5= strongly agree

The only question that relates to Critical Component #5 is statement #13 in Table 5, which inquires about noise or other distraction that make concentration difficult. The results suggest that noise is somewhat a factor in distracting students from their tasks. Because two or more workshop groups are often assigned to the same room, the Peer Leaders and students must accommodate each other, choosing a section of the room, preferably near a board to share solutions. Space is often a constraint, especially when several workshop sessions are scheduled at the same time.

Table 5. Responses to Questions Related to Critical Component #5

Critical Component #5:Time and space are designated for workshop sessions							
Survey Question Number	Statement	General Chemistry I			General Chemistry II		
		Spring 2008	Fall 2008	Spring 2009	Spring 2008	Fall 2008	Spring 2009
13	Noise or other distractions make it difficult to benefit from the workshops.	2.51	2.60	2.68	3.21	2.70	2.90

*Survey scale with 1= strongly disagree and 5= strongly agree

Successful workshop programs require the investment of substantial resources in terms of faculty time and energy, compensation for the workshop leaders (through hourly wages, stipends, or some other method of rewards), and a developed system of running the workshop program so that the organizational tasks are accomplished each semester. Consequently, even committed faculty members sometimes lose interest if the program is not promoted and supported with resources or recognition by the administration. The two questions that relate to Critical Component #6 are reflected in Questions #9 and #19 in Table 6.The results for #9 speak to students' satisfaction with the program, as most would "recommend workshop courses to other students." Fewer would consider serving as a workshop leader (#19); this result might reflect the large number of freshmen students who take General Chemistry who were learning to navigate college. Students correctly understand that the role of workshop leader requires a serious interest in chemistry and commitment to the work required for leadership.

Table 6.Responses to Questions Related to Critical Component #6

Critical Component #6: There is institutional support							
Survey Question Number	Statement	General Chemistry I			General Chemistry II		
		Spring 2008	Fall 2008	Spring 2009	Spring 2008	Fall 2008	Spring 2009
9	I would recommend workshop courses to other students.	4.19	4.20	4.25	3.79	3.90	4.14
19	I would like to be a workshop leader in the future.	2.84	3.00	4.24	3.00	3.20	4.05

*Survey scale with 1= strongly disagree and 5= strongly agree

This group of questions (#6, 18, 20, and 21) in Table 7 addresses attitudes and beliefs. Students generally agree that workshops help improve their grade (#6), workshops help in solving problems (#18), and they enjoy interacting with other students (#20). An additional benefit is that more than half of the respondents acknowledge that the workshop experience led them to join a study group (#21). This outcome is important at an urban commuter campus because students will have a mechanism of interacting with other students. These questions relate indirectly to Critical Component #6 as they provide support for student engagement, which is a basis for satisfaction, and could be further explored as a measure of institutional retention.

Table 7. Responses to Questions of Attitudes of Students toward Workshops

Attitudes of Students							
Survey Question Number	Statement	General Chemistry I			General Chemistry II		
		Spring 2008	Fall 2008	Spring 2009	Spring 2008	Fall 2008	Spring 2009
6	I believe that the workshops are improving my grade.	3.91	3.80	4.09	3.42	3.65	3.81
18	The workshops are a big help in solving problems.	3.97	4.10	3.01	3.60	3.85	3.21
20	In the workshops I enjoy interacting with the other students.	4.09	4.20	3.19	3.87	4.10	3.24
21	The workshop experience led me to join formal or informal study group related to other courses.	3.34	3.20	2.53	3.11	3.40	2.69

*Survey scale with 1= strongly disagree and 5= strongly agree

Question #22 in Table 8 provides a range of number of hours spent studying for General Chemistry. For all semesters, the average number of hours spent studying outside of class would be about four hours. The time spent in the weekly workshop session would also contribute to the number of hours studying, in effect increasing studying effectiveness.

Table 8. Time Spent Studying Per Week

Time Spent Studying Per Week							
Survey Question Number	Statement	General Chemistry I			General Chemistry II		
		Spring 2008	Fall 2008	Spring 2009	Spring 2008	Fall 2008	Spring 2009
22	On average, I spend the following number of hours per week studying (in addition to time spent at lectures and workshops): **1)**0-2 hours**2)** 2-4 hours **3)** 4-6 hours**4)** 6-8 hours **5)**8-10 hours	2.39	2.70	2.45	2.47	2.80	2.52

*Survey scale with **1=**0-2 hours; **2=** 2-4 hours; **3=** 4-6 hours; **4=** 6-8 hours; **5=** 8-10 hours

Discussion

No question on the survey was directly related to Critical Component #2: "Instructors (faculty & teachers) are involved in the selection of materials, training and supervision of Peer Leaders, and they review the progress of Workshops." This may seem obvious because the questionnaire focuses on students' views of their workshop experience. Because workshops are led by Peer Leaders, the students do not see the work that is necessary to coordinate a PLTL program. The weekly coordination involves instructors and Peer Leaders, and the forum for ensuring alignment is the weekly "prep" session, where

content for the next workshop is reviewed, and feedback is provided by the Peer Leaders to the instructors. This component is vital to unifying the lecture, exams, and workshop. Table 9 summarizes the questions presented in Table 2 (CC #1), specifically #1, #2, and #11, and in Table 4 (CC #4), specifically #23, and #4, that provide feedback on the outcome of such coordinating efforts. Notably, Question #11 (The lecture encourages us to participate in the workshops) does express the active promotion of workshop by the course professor.

Table 9.Responses to Questions Related to Critical Component #2

Critical Component #2: Faculty/ Instructors are Involved							
Survey Question Number	Statement	General Chemistry I			General Chemistry II		
		Spring 2008	Fall 2008	Spring 2009	Spring 2008	Fall 2008	Spring 2009
1 (CC#1)	The workshops are closely related to the material taught in the lectures.	4.00	4.40	4.49	4.10	4.35	4.49
2 (CC#1)	Workshops help me do better in tests.	4.14	4.10	4.30	3.58	3.75	4.07
11 (CC#1)	The lecture encourages us to participate in the workshops.	3.75	3.70	4.03	3.76	4.00	4.12
23 (CC #4)	The materials are well connected with the lecture.	3.96	4.10	4.07	3.86	4.05	4.23
4 (CC #4)	The workshop materials are helpful preparation for exams.	4.14	4.00	4.28	3.59	3.85	4.15

*Survey scale with 1= strongly disagree and 5= strongly agree

The results presented here speak to overall satisfaction with the workshop program. For most of the students in General Chemistry I, it may be their first semester in college, and they are introduced to learning a challenging subject in a supportive environment. For others, the supportive environment provides an alternative way of studying, through discussion and interaction, allowing them to test their ideas and problem-solving approaches.

These results are from a "mature" PLTL workshop program at the City College of New York, where every student taking General Chemistry must participate in workshop; this model has been in place for well over a decade. A well-coordinated system is in place with institutional support in scheduling, departmental support, and financial support for the Peer Leaders. Having a workable and stable model and receiving satisfactory feedback from students provide programmatic dimensions that allow comparisons with PLTL programs at other campuses. The results of the data collected from three semesters demonstrate that there is intrinsic value placed upon the workshop program by students, and these results can be reviewed to improve the program.

Conclusions

In promoting and attempting to disseminate new practices, several questions are asked: What is it? How does it work? Why does it work? (Rogers, 2003). With PLTL, explaining what it is and how it is to be

done are straightforward; however, explaining the why is more complex. Success or failure of a program rests with understanding both "how" and "why." This is where the six critical components are supremely important in implementing PLTL workshops.

In reviewing adherence to the PLTL model's six Critical Components at various campuses, it is clear that when there was evident success, it was always because the critical components were completely adhered to. When there were challenges, it was usually attributed to one or more critical components not being in place. These critical components therefore make both dissemination and implementations possible. In addition, they add a quality of objectivity to the discussion. And this objective measure can help break down the resistance that sometimes accompanies the "not invented here" syndrome. Those presenting and explaining PLTL do not rely on their own experiences or expertise; they point to a method with proven success and explain how it has been widely implemented successfully, despite variable local issues at different types of campuses. Using the Gafney Survey and comparing the results to the Critical Components as was done here provide a useful way of checking how students or other stakeholders view their PLTL program.

Rogers (2003) also describes a number of characteristics of innovations that are likely to be in the minds of potential adopters. A few of the major concerns are complexity; relative advantage; and trialability ("how difficult will this be to implement and sustain?"). Interested faculty and administrators, who are considering adopting the PLTL model often express concerns about these three areas. The critical components may not bear directly on these issues but they can provide a standard guideline, as viewed in these results. PLTL is complex, but with a model that has been tried and tested and found to work, the adopter has a great advantage over one that has not. 'Relative advantage' is somewhat a matter of individual preference, but the data from grades and student responses provide a great deal of evidence that the method generally works well as active learning, better than lectures alone or even when accompanied by recitations. Finally, regarding 'trialability,' those considering the method want some assurance that trying it will not take time and resources out of proportion to the benefits. While faculty members must decide this issue for themselves, the critical components remove the guesswork from a trial program, and allow the opportunity for continued refinements and improvements.

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