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The Scholarship of Peer-Led Team Learning: My progression from student leader to faculty

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Abstract

Twenty years ago, I was an undergraduate majoring in Biology and Chemistry, struggling with the desire to integrate the details I had learned in my Chemistry courses with the 'big picture' philosophy stressed in my Biology curriculum. These early educational experiences fostered my passion for curricula geared towards interdisciplinary learning and in programs designed to increase awareness of alternative learning styles and pedagogies for instruction. My Workshop journey began shortly thereafter with PLTL's inception at the University of Rochester. Now as a faculty member, I have implemented PLTL and two other pedagogies into my General Chemistry, Organic Chemistry, and Biochemistry curricula with a "full-circle" perspective that has been nearly two decades in the making. This article will examine the evolution of my educational philosophy as I progressed from student leader to faculty as well as some strategies I have found useful for its implementation and means to involve these alternative pedagogies in my scholarly activities for promotion and tenure.

Academic Scholarship

Webster defines scholarship as "the character, qualities, activities, or attainments of a learned person" (Mirriam-Webster). How scholarship is viewed from a personal standpoint is a process in evolution. When we first begin our education, our activities and attainments are modest and generally revolve around a general theme of living a balanced life of work, play, and learning (Fulghum, 1988). While the scope of these activities changes as we progress through our institutes of higher learning, the hope is that the seed for a love of life-long learning is planted (Fischer, 2000). For undergraduates, scholarship is more frequently defined through an attainment of a specific grade point average, rather than the development of their scholarly character or the participation in course activities that allow them to master the course content that will earn them that A.

For those more entrenched in the academic community, scholarship is generally defined as a tripartite mission of teaching, research, and service – the foundational tenets of a complete faculty member, Figure 1. Some faculty struggle because they see each of these areas of scholarship as an independent entities. Others work to integrate these activities such that they play a synergistic role in their path towards tenure (Sharobeam & Howard, 2002). In this way, faculty often choose to complement their research portfolio with publications on pedagogy and participate in service activities that draw on their strengths in the classroom (Eichinger & Krockover, 1998). However, as the rules appear to be evolving with regards to the process of promotion and tenure (Youn & Price, 2009), it is even more essential for faculty to carefully plan how to divide their time, effort, and resources among these three areas of scholarship so as to best navigate their pathway to tenure.

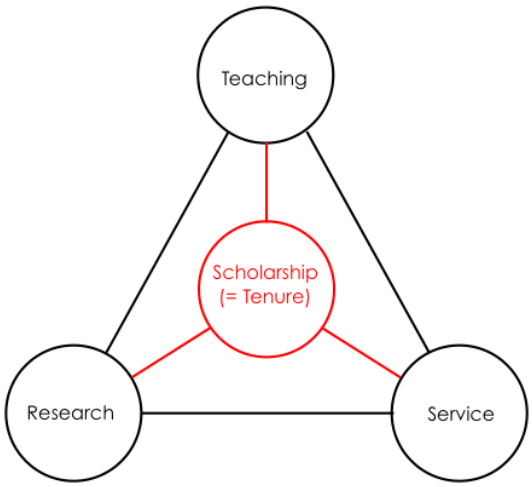

Figure 1 – The tripartite mission of a faculty scholar – teaching, research, and service.

This article provides details on three alternative pedagogies the author has integrated into her scholarly work through incorporation into her General Chemistry, Organic Chemistry, and Biochemistry courses; Mastery Learning with Competency-Based Grading and Peer-Led Team Learning (PLTL). Mastery learning is a *method of instruction* based on the premise that students learn best when they fully understand, or master, one concept before moving onto the next. Competency-based grading is an *evaluative tool* that allows the faculty member to determine the level of mastery students must achieve, but allows the student the choice to work beyond this base level of mastery for a higher grade. Peer-Led Team Learning is a *method of student learning* whereby peer leaders work collaboratively with students in small groups to facilitate student mastery of the key concept material for the course. Details on the implementation process, challenges, and future directions are discussed below.

Mastery Learning

John Carroll first pointed out in 1963 that students differ in the amount of time they need to learn material to a set level of competency (Carroll, 1963) – thus time is the central variable. This was further refined in 1968 by Benjamin Bloom (1968), and later by James Block in 1971 (B.S. Bloom, 1971) to indicate that faculty must define what is meant by "mastery of a subject" and then identify the materials and methods best suited to help the greatest proportion of students reach this level. Indeed, about 80% of students in a mastery learning class will reach the same final achievement level as 20% of the students under conventional instruction (B. S. Bloom, 1974, 1978).

Placing mastery learning in a simpler context, a program useful to parents of picky eaters incorporates a "What, When, How Much, and Whether" rule (Obleman, 2007). Parents have the responsibility of choosing *what* and *when* their children eat, but the child can choose *whether* they will eat and *how much* they will eat. Translation of this philosophy to the mastery learning classroom, the instructor has the responsibility of choosing *what* is important for students to learn (a base-level of knowledge defined by key concepts) and determines *when* students must learn these by (time to mastery or the course end date). However, students can choose *how much* work to put into the class and *whether* they will apply their base knowledge to earn a better grade.

A key component to mastery learning states that time is the central variable. There is a tremendous amount of pressure on a student to learn at the same rate as the group, despite the fact that learners differ by a ratio of about 5:1 in their learning times; meaning that the slowest 5% of learners take about five times as much time to reach a level of mastery as the fastest 5% of learners (B. S. Bloom, 1974). As indicated previously, when time is removed from the equation, a majority of students (80%) will be able to attain a predetermined level of mastery. However, this sets up an obvious paradox when considering the fixed time frame under which course instruction generally proceeds. This can be circumvented by allowing course instruction to proceed at the same pace for all students while allowing time to mastery of key concepts to remain variable.

At its core, mastery learning is an instructional method that allows the students to master specified concepts within the course (the instructor's goal) while allowing students to earn a grade that is consistent with the level of mastery they desire (the student's goal). By definition, the level of mastery is at or above the minimum requirements for specified concepts of the course. How to properly assess student attainment of mastery can be a challenge, but can be facilitated by competency-based grading.

Competency-Based Grading

One concern with "student-driven" grading systems is that while they allow students to take more ownership of their learning (and thus their grade), this can diminish the educator's role in ensuring mastery of the essential key concepts of the course. As mastery learning inherently implies attainment of a certain level of competency, competency-based grading as an evaluative tool is a logical companion with a mastery learning instructional tool.

Learning objectives are created for course key concepts and this helps define the content of the group instruction that proceeds at a normal pace. Criterion-based assessment materials are generated to evaluate student progress toward the concept's learning objectives. Students able to demonstrate mastery of the concepts and skills are encouraged to engage in enrichment or extension activities to broaden and expand their learning. The feedback, corrective, and enrichment process of mastery learning is shown in Figure 2 (Diegelman-Parente, 2011) and highlights the varied components critical towards elevating a student's understanding to the mastery (competency) level expected by the instructor.

Competency levels are established for a number of identified concepts, and achievement of mastery is evaluated by formative assessment. Competency must be achieved on each of the identified core concepts. If not, corrective actions are taken, such as tutoring or working additional problems. A new formative assessment is then completed. The process is revisited until competency is established. Repeated lack of mastery may require an intervention or meeting with the instructor to identify and help to correct the student issues. If mastery is achieved, the student has the option of working toward a higher level of competency (above the minimum) and a higher grade. The student may also *choose* not to pursue a higher level of competency and is thus content with the minimum grade.

Students who do not satisfactorily master a topic are allowed additional time and opportunity to do so with a few stipulations. This includes a maximum number of times a student is allowed a repeat formative assessments and checkpoints that require mastery of prior concepts. Previous work has indicated that students who cannot reach mastery of early concepts after four total attempts, or by the half-way point of the course generally are never able to do so (Diegelman-Parente, 2008).

At its core, competency-based grading thus allows the instructor to determine the criterion-level the student must achieve to demonstrate mastery, but allows the student nearly unlimited time and opportunity to reach this level.

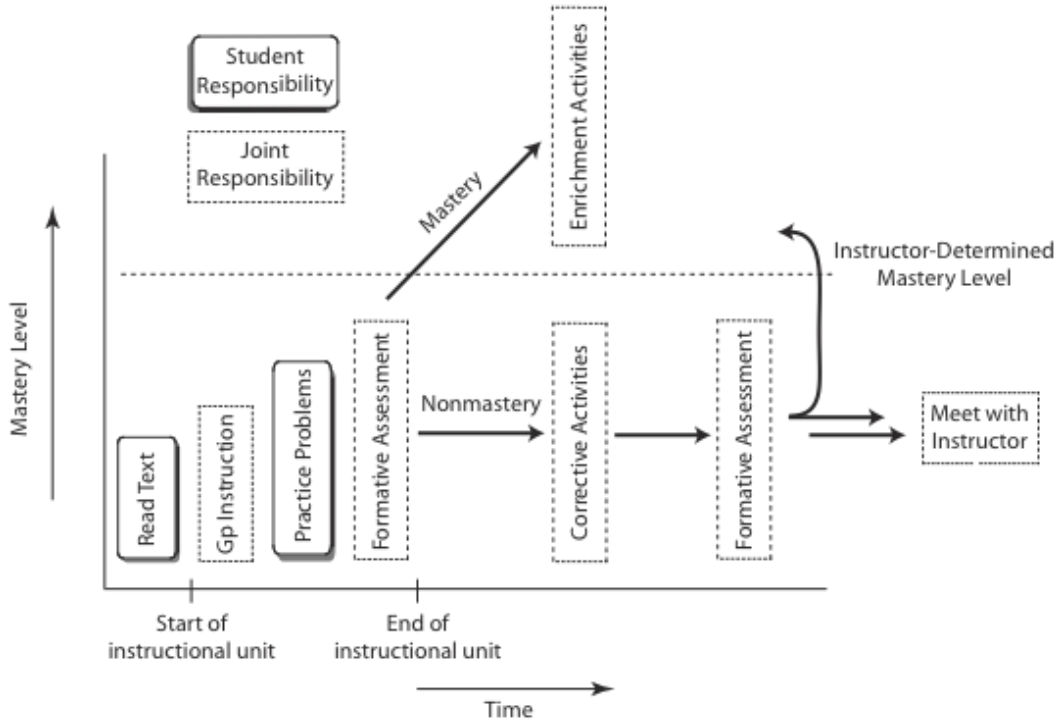

Figure 2 – feedback, corrective, and enrichment process of mastery learning.

Peer-Led Team Learning

Peer-Led Team Learning (PLTL) is an innovative model in science education whereby student-leaders (peers) guide the activities of small groups of students in weekly Workshop meetings (D. R. Gosser, V.; Gafney, L.; Kampmeier, J.; Strozak,V.; Varma- & Nelson, 1996; Mitchell, Ippolito, & Lewis, 2012; Tien, Roth, & Kampmeier, 2002). The students work through challenging problems that are designed to be solved cooperatively. Central to the success of this model of student learning is the active involvement of four groups (Figure 3):

- Faculty *teaching* the course
- Students *taking* the course
- Workshop (Peer) Leaders *facilitating* the understanding of their peers
- Learning specialists involved in *training* and *guiding* the peer leaders

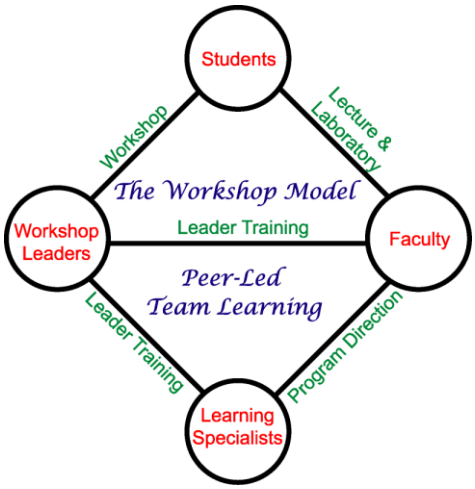

Figure 3 – Four essential groups for PLTL success – engaged faculty, interested students, properly trained leaders, and involved learning specialists (adapted from (D. K. Gosser et al., 2001).

The roles played by each of the four groups in the PLTL process are equally important to fulfilling the six critical components of a successful workshop program – Table 1 (PLTLIS)

Table 1: Six Critical Components of the Workshop

1. The Workshop is integral to the course.
2. Course professors are involved in the selection of materials, training and supervision of peer leaders, and they review 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 tests, designed for small group work.
5. The Workshops are held once a week for two hours, contain six to eight students per group, in space suitable for small-group activities.
6. PLTL is supported by the department and the institution with funds, course status and other support so that the method has the opportunity to be adopted across courses and disciplines.

At its core, Peer-Led Team Learning can be a critical element in a mastery learning course, as Workshops present an ideal forum for students to work with their peers on mastery of key concepts. In this way, several critical components of Workshop are satisfied. Workshop is integral to the course (critical component 1) by using workshop materials that are carefully selected by the professor (critical component 2) to reflect the learning objectives of the key concepts which are the subject of assessment materials (critical component 4).

Incorporation of Alternative Pedagogies in Organic Chemistry – *choosing key concepts*

Organic Chemistry, in which concepts are largely hierarchical and difficult to master by simple memorization, presents an ideal course in which to incorporate mastery learning. Content for the course is presented in instructional units termed key concepts whereby learning objectives are the concepts or skills that are most important for students to master. Generally between six and ten discrete topics will generate the key concept list for a course, Table 2 (Diegelman-Parente, 2011). A common key concept for upper-level courses is a demonstrated mastery of prerequisite knowledge, in this case several aspects of General Chemistry (Organic Chemistry fundamentals).

Table 2: Key Concepts for Organic Chemistry		
Key Concept	**Organic Chemistry I**	**Organic Chemistry II**
1	Organic Chemistry fundamentals	Identification of compounds
2	Understanding organic structure	Carbonyl compounds I
3	Understanding organic reactions	Carbonyl compounds II
4	Reactions of alkenes	Carbonyl compounds III
5	Stereochemistry and alkynes	Assimilating organic chemistry
Key Concept Checkpoint #1		
6	Delocalized electrons	Carbohydrates
7	Substitution/elimination reactions	Amino acids, peptides, proteins
8	Assimilating organic chemistry	Lipids
Key Concept Checkpoint #2		
9	Reactions of alkanes	Nucleosides, nucleotides, nucleic acids
10	Reactions of aromatic compounds	Pericyclic reactions

Peer-Led Team Learning has become a critical component in the mastery learning with competency-based framework in many ways. Initially, it provides a structured forum for students to practice problems outside of the classroom *prior* to a formative assessment. Subsequently, workshops can further assist students who did not demonstrate mastery in a key concept *after* the formative assessment by working on additional corrective activities. Finally, more advanced workshop materials can be useful for students mastering key concepts by furthering their understanding with enrichment activities.

Incorporation of Alternative Pedagogies in General Chemistry – *working with existing resources*

Many faculty simply choose to replace existing traditional faculty-led recitation sessions with Workshops as an initial means for implementation of Peer-Led Team Learning in the curriculum (Platt, Barber, Yoshinaka, & Roth, 2006). However, if formal recitations are not part of the academic culture at an institution, incorporating Peer-Led Team Learning into the curriculum can afford a unique opportunity for collaboration with a tutoring center. Tutoring centers frequently struggle with an increasing number of tutoring requests coupled with a very limited pool of tutors. Many utilize supplemental instruction (SI) sessions run by their tutors (Rath, Peterfreund, Bayliss, Runquist, & Simonis, 2012) as a means to meet supply-demand issues. However, without significant faculty involvement, tutors may not be adequately prepared from either a course content or process standpoint (management of group work) to have either party feel successful with the outcome.

The good news is that SI already provides the framework for PLTL Workshops. All that is missing is faculty engagement to direct the Learning Specialists, Leaders, and Students in their specific roles (Figure 3). The tutoring center becomes responsible for the training of the peer leaders on ***process*** while the faculty member assumes responsibility for managing the delivery and packaging of course ***content*** such that the peer leaders are comfortable with the material and students have transparency with course expectations.

Incorporation of Alternative Pedagogies in Biochemistry – *creative sources for peer leaders*

As even the name implies, the field of Biochemistry is an integrative science, drawing on concepts from Biology as well as General Chemistry and Organic Chemistry. Like Organic Chemistry, the hierarchical nature of concepts in Biochemistry lends itself well to a mastery learning philosophy, however, a major

challenge with many students is the extent of prerequisite knowledge required for mastery of Biochemistry-specific content. Thus, the "learning curve" can be much more substantial. Key concepts and instructional tools generated for this full year course followed the feedback, corrective, and enrichment process shown in Figure 2.

Integration of alternative pedagogies in a Biochemistry curriculum can come with its own unique challenges, with particular regard to Peer-Led Team Learning. General Chemistry and Organic Chemistry Workshops (generally freshman and sophomore-level courses) lend themselves well to facilitation by upperclass peer leaders. Biochemistry is a junior level course, frequently taken by seniors who graduate shortly after mastering the course. In this way, workshops are missing a critical component in having peer leaders who had successfully completed the course material. However, for Chemistry departments with curriculum wide integration of PLTL, Biochemistry students are frequently current or prior peer leaders for Organic Chemistry Workshops, and are already well versed in the workings of Peer-Lead Team Learning. As such, workshop leader duties can be rotated among these students who are able to serve as true "peers" in these Workshops, taking the course concurrently.

Your Academic Budget – *a cautionary word on implementing alternative pedagogies*

Knock on any junior faculty member's office and ask them what they are doing, and chances are they will tell you – "preparing lecture," or "writing an exam," or just simply "grading." Bottom-line, they will generally be working on something for teaching – and that's easy to do. In the academic triage of what prioritizing what needs to get done today, you can't have class tomorrow if you don't have lecture prepared today. You also cannot let students know if they are meeting your expectations unless you prepare adequate assessment materials and get feedback to them in a timely fashion. In this way, it is very easy to let your teaching demands use up the entirety of your work time and then some. Teaching is like a gas; it expands to fill all of the available space. Plus, there is a sense of accomplishment in seeing a tangible product from a day's work – tomorrow's lecture, a well-written (or so we think) exam, or a pile of assignments moved into the "done" category on a to-do list. However, much like financial currency is frequently spent on needs of today, forgetting to save for the future, faculty need to realize the importance of budgeting ***time,*** not only for the teaching that must get done today, but for the other areas of scholarship that are equally important for creating a complete faculty member.

While investing time in alternative pedagogies can reap great rewards from both a teaching and research standpoint, they can also sap your time and energy for other important scholarly endeavors. Additionally, while earning credit for pedagogical research is of value, scholarship in a discipline-specific area of laboratory-based research is generally still a requirement. As such, in the budgeting of academic time, be sure to leave ample blocks of time to develop an independent line of laboratory-based research. Additionally, learn the value of the three "Rs" of scholarship: read, write, and review. ***Read*** – keep current with the literature in your field – it will be amazing how much this can invigorate your classroom teaching. ***Write*** – one of the most important skills to develop as scientists is the ability to communicate ideas to others. This has several important tangibles including publications (which are generally needed for tenure), and grants (which will bring institutional happiness and help pay for continued research activities). ***Review*** – reading other scholars' as yet unpublished writings gives a glimpse into what is new and exciting, and helps in the continual development of authorship skills.

A Final Word on Academic Scholarship

Robert Fulghum tells us in kindergarten to live a balanced life of work, play, and learning (Fulghum, 1988). While the immediate goals towards this end change as we grow, as is the case with the tripartite

mission of academic scholarship (Figure 1) or the fundamental pillars for successful alternative pedagogies (Figure 3), the goal is to strive for balance and ideally integration in all three areas (Figure 4). In many ways, the life of an academic can help achieve this balance, and might have been best summed up by Lawrence Pearsall Jacks (Jacks, 1932):

"A master in the art of living draws no sharp distinction between his work and his play, his labour and his leisure, his mind and his body, his education and his recreation. He hardly knows which is which. He simply pursues his vision of excellence through whatever he is doing and leaves others to determine whether he is working or playing. To himself he always seems to be doing both. Enough for him that he does it well."

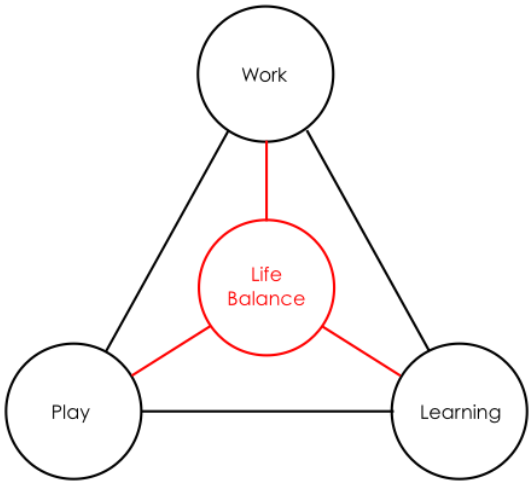

Figure 4 – Keys to a successful life balance.

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