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DEVELOPING WORKBOOKS TO SUPPORT PLTL PROGRAMS FINANCIALLY

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The University of Texas at El Paso (UTEP) has developed and enhanced the talent pool of undergraduate students in science and engineering from the Paso del Norte region of the United States by implementing and honing the learning intervention of Peer Led Team Learning (PLTL) in General Chemistry I and II. Our 15-year program is now significantly funded via a self-sustaining, self-funding strategy involving the creation and sale of Workbooks, student-authored learning materials published through a collaborating non-profit publisher. As in other PLTL programs, students enroll in lecture and must co-register in required, small-section PLTL Workshops. The learning in each Workshop is facilitated by an undergraduate Peer Leader, a student who has done well in the course and has been trained for the purpose. Funds to pay the leaders initially came from National Science Foundation (NSF) grants. When external funding neared an end, this very successful PLTL intervention was continued by involving the Peer Leaders themselves in authoring learning materials. The undergraduate-Leader-authored materials represent intellectual property. This IP is donated to a non-profit (Lead For America Corporation), which organizes the materials into learning modules in Workbooks, and the Workbooks are sold to the local bookstore. What would normally be called 'royalties' by a book publisher are donated by the non-profit publisher to a university Gift Fund, with the Gift Fund providing a cost center used for paying for training costs and for the hourly wages of the Leaders. Workbooks organize the content of the PLTL Workshops, provide content sequence for faculty lecturers, and significantly fund the program.

At the third PLTLIS annual conference in 2014, held at California State University, Dominguez Hills, we described how the publication, sale and use of workbooks can fund a PLTL program as well as provide structure to the week-by-week workshop and lecture content. The process to create a workbook in support of PLTL workshops in any course within any discipline begins with identifying the topics covered as stated in the syllabus. Because the semester is fourteen/fifteen weeks, the workbook should consist of fourteen/fifteen parts. Each part supports workshop (and lecture) in a given week and can contain learning materials, e.g. explanations, representative examples, practice problems, quizzes, and self-assessments for peer leaders to use. As a start, much of this can be constructed from original examination problems. The draft workbook can be revised, modified, and expanded semester after semester by each new class of peer leaders and instructors.

As an example, here is the textbook content for General Chemistry 2: Ten 'Chapters'/'Units'/Segments

1. Review of Lewis Structures, Bonding and Molecular Geometry
2. Carbon and Organic Chemistry
3. Intermolecular Forces, Liquids, and Solids
4. Physical Properties of Solutions
5. Chemical Kinetics
6. Chemical Equilibrium
7. Chemistry of Acids and Bases
8. Acid-Base Equilibria and Solubility Equilibria
9. Entropy, Free Energy, and Equilibrium
10. Electrochemistry

The General Chemistry 2 Workbook is subdivided into 14 'Units' or 'Modules'

Week of Semester (Sample dates)	Topic	Topic	Homework
Week 1 (January 20th - 23rd)	Rule of 7	Lewis Structures	Week 1 Homework
Week 2 (January 26th - 30th)	Resonance	Hybridization, VSEPR	Week 2 Homework
Week 3 (February 2nd - 6th)	Organic Chemistry <i>Exam I Review; Explorations</i>	Organic Reactions <i>Exam I Review Problems</i>	Week 3 Homework
Week 4 (February 9th - 13th)	Intermolecular Forces; Phase Diagrams	Properties of Compounds; Solubility, Insolubility, Miscibility	Week 4 Homework
Week 5 (February 16th - 20th)	Concentration Units; Henry's Law; Osmosis	Colligative Properties; Raoult's Law; Boiling Point Elevation and Freezing Point Depression; Electrolytes	Week 5 Homework
Week 6 (February 23rd - 27th)	Kinetics Plotting Reaction Progression		Week 6 Homework
Week 7 (March 2nd - 6th)	Rate Law; Integrated Rate Equations <i>Exam II Review Explorations</i>	Arrhenius Theory <i>Exam II Review Problems</i>	Week 7 Homework
Week 8 (March 16th - 20th)	Equilibrium; Kc and Kp Expressions	K vs. Q Plotting Reaction Progression in Equilibrium; Le Chatelier's Principle	Week 8 Homework
Week 9 (March 23rd - 27th)	Bronsted Acids and Bases	Dissociation Constants and Measures of Acidity and Basicity	Week 9 Homework

Week of Semester (Sample dates)	Topic	Topic	Homework
Week 10 (March 30th - April 2nd)	Polyprotic Acids <i>Exam III Review Beans</i> <i>Equilibrium Explorations</i>	Acidic and Basic Salts; Lewis Acids and Bases <i>Exam III Review Problems</i>	Week 10 Homework
Week 11 (April 6th - 10th)	Buffers	Titrations	Week 11 Homework
Week 12 (April 13th - 17th)	Solubility and the K _{sp} Constant	Solubility Effects	Week 12 Homework
Week 13 (April 20th - 24th)	Second Law of Thermodynamics	Gibbs Free Energy	Week 13 Homework
Week 14 (April 27th - May 1st)	Oxidation and Reduction; Galvanic Cells <i>Exam IV Review Explorations</i>	Balancing Redox Reactions; Electrolysis <i>Exam IV Review Problems</i>	Week 14 Homework

Process of Creating the Workbooks

Recognizing the need for a new funding source (as the grants were about to end) to maintain the payment of leaders in the PLTL Program, the chemistry faculty at UTEP wrote initial versions of two workbooks for use in workshops beginning in 2012. However, the University of Texas System required that these faculty-authored workbooks not be priced more than \$5.00 above the cost of production, a profit margin too small for the purpose of generating funds sufficient to pay the Leaders. However, Peer Leaders, by virtue of their familiarity with content and with the difficulties their workshop students encounter, offered in 2013 to start creating materials and practice problems for use in developing new workbooks, one for each course having PLTL workshops.

Involvement of the Leaders in workbook generation enables the entire financial process because internal institutional pricing restrictions are placed on student-authored materials, so long as the materials are written on the students' own time (not as part of school or Peer Leader activities) and without university support and facilities (such as computers). Peer Leaders have shown themselves to be quite altruistic. They are driven by a sense of helping others. They are willing to donate their intellectual property to enable a more successful program. They assign the legal rights to their intellectual work-product to the nonprofit publisher, Lead For America, LFAC. Contributors of IP receive authorship recognition for their intellectual creativity and their names can appear on the sections they author within the workbooks. Semester after semester, the succession of new leaders revise, edit, and contribute new materials to new workbooks. Workbooks are organized by the nonprofit. Suggestions for improvement are also taken from the faculty actually teaching the course. LFAC sells the workbooks to the campus bookstore and receives payment from the bookstore from the sales. Because LFAC is a (501)(c)(3) organization, no federal or state taxes are

involved in payments received. Profit received by LFAC, over printing costs, are donated to a university gift fund, which is designated to be used only to support PLTL

Printing workbooks on a different color of paper each semester (or every year) assures that Leaders can easily ascertain that their students are purchasing the newest workbook and that it is not photocopied illegally. Assigned homework problem sets are ripped out by the workshop students to be graded by the Leaders. In this way, workbooks are consumed by the students each semester. The faculty allow (and recommend) that students purchase inexpensive used copies of the required textbooks online, but require students to purchase a new copy of the workbook for the course, which is priced far less expensively than a new textbook.

Leaders generate Intellectual Property. The IP is donated to a nonprofit. The nonprofit sells to students via bookstores. Bookstores make payments to the nonprofit. The nonprofit donates royalties to a university gift fund. The gift fund pays costs of the PLTL Program. The cycle continues. This is the funding model developed at the University of Texas at El Paso.

Expansion of Concept

A team submitted a proposal to the National Science Foundation's Innovation Corps for Learning program in the Fall of 2014, and was accepted for the first official program of I-Corps-L. Geoffrey Saupe served as Principal Investigator and AE Dreyfuss was the "Entrepreneurial Lead" for Team 18, *SusSTEM*, which was mentored by James E. Becvar and Wayne Johnson (who had chaired the Advisory Committee of the NSF STEP grant which formerly supported the UTEP PLTL program).

The grant was for a six-month period, from January through June 2015 and was focused on training participating teams and on the process of creating a start-up business. The training program began the first weekend in January 2015, where each of over thirty teams from universities across the United States were first introduced to the concepts of building a company as developed by Silicon Valley entrepreneur Steve Blank. This training focuses on ensuring that a start-up idea is first explored with would-be customers and is then developed based on the feedback received.

Over the course of eight weeks, Team 18, *SusSTEM*, conducted 104 interviews, primarily with practitioners of PLTL, including faculty, administrators, and Peer Leaders. Each week, the team reported their progress and new findings through a webinar with other teams, presenting an updated "Business Model Canvas" which would include new concepts. These include determining or refining "Value Propositions," depending on what was discovered in that week's interviews. How did the team expect its product to demonstrate its value?

Other business concepts that the team learned about and subsequently included were examining "Customer Segments," possible business channels, key resources, activities, and possible partners. The training ended after eight weeks with the presentation of a completed Business Model Canvas, and two videos. The two-minute video of our team is available at <https://www.youtube.com/watch?v=1hmoonckPCo>

What Team 18, *SusSTEM*, found was that PLTL practitioners at many campuses write materials for workshops, and hence they already produce IP that could be contributed to a workbook. Two campuses sell the materials to students to support payment of Peer Leaders – this finding indicated that our idea had

greater worth. The funding model, originally developed at the University of Texas at El Paso, which incorporates the work of Peer Leaders, became the basis for the first version of the PLTLIS funding model as shown in Figure 1.

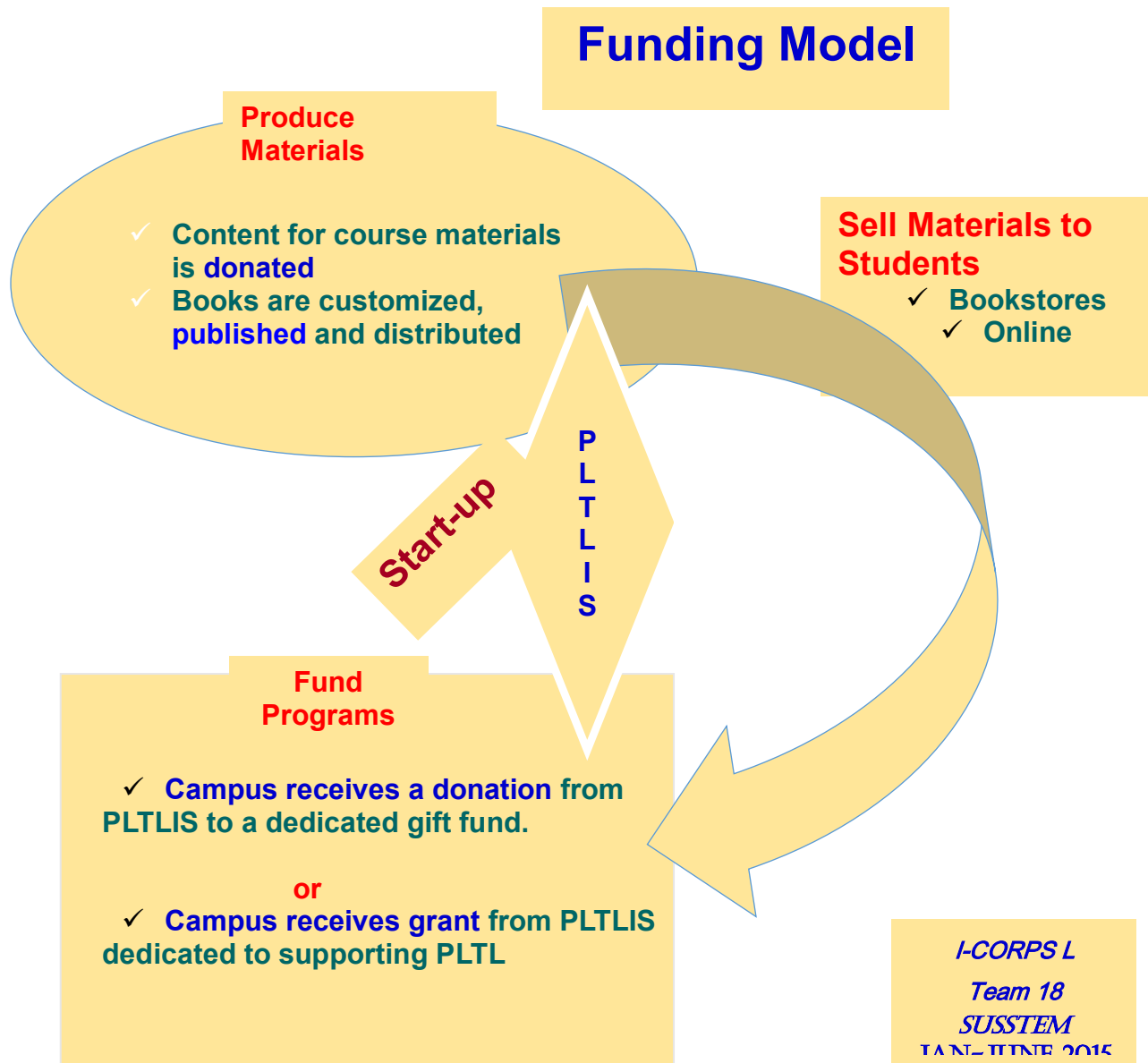


Figure 1. Initial Funding Model, Team 18 *SusSTEM*, February 2015

Prior to the 2015 PLTLIS Conference held at the University of Texas at Dallas, a one-day Writing Workshop convened on May 27, where teams of faculty and Peer Leaders were introduced to the process of constructing workbooks in several disciplines and courses within disciplines. After discussing the model, participants in several disciplines were organized into teams interested in specific courses, such as first semester general biology, pre-calculus, and organic chemistry. Each team, with representatives from several institutions, then set about trying to define the scope of the content of the specific course. Each team organized and identified a set of approximately fifteen modules that might be developed to define a semester of workshops to support a PLTL program for each course - and thus the scope composing a workbook. A difficulty recognized is that courses at different institutions have slightly different content and therefore may need a slightly different set of modules to represent a workbook.

With the combined efforts of faculty and Peer Leaders, campus programs can create and organize learning materials and modules that can be shared across campuses to support the practice of PLTL. Programs can become (at least) partially sustainable by the process described here. PLTLIS can become a publishing house to organize materials into course-specific workbooks. Funds generated locally from the sale of workbooks can then be donated to a local campus gift fund and can support any cost a campus needs in order to sustain its program.

We invite PLTL practitioners to contact us at info@ptlis.org.

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