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Core Sciences in First-Year Learning Communities

Abstract
Learning communities (LCs) offer high-impact practices of active learning and practical application, but such practices demand devoted class time and room for reflection. Core science courses that serve as prerequisites for more advanced courses have specific and fixed content that offers no space in which to incorporate the ideals of LCs. Wagner College's three-course model for first-year LCs solves this conundrum by providing a Reflective Tutorial (RFT)—a course dedicated to critical thinking, frequent writing, reflection, and practical application through experiential learning—that bridges two content courses based on a well-developed theme. This structure allows any course appropriate for first-year students, including core science courses, to be incorporated in an LC. Two faculty members work as a team to create the three-course LC; each faculty member teaches one of the content courses to the same group of 24-28 students. The two instructors team teach the RFT or offer independent small sections of the RFT; the RFT replaces the traditional first-year writing course. Specific examples are provided of LCs incorporating a core science course.

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Introduction

The Association of American Colleges and Universities (AAC&U) has identified a set of high-impact practices as part of its LEAP (Liberal Education and America's Promise) Initiative (Kuh, 2008). Excellent educational practices that lead to student success include first-year experiences with critical thinking, frequent writing, and collaborative learning. Learning communities, writing-intensive courses, and service learning/community-based learning have been identified as ideal practices. The benefits of learning communities (LCs) in particular have been broadly acknowledged. A quick overview of the literature reveals multiple reasons why LCs are beneficial for improving student success, including retention, quality of learning, and student involvement (Tampke & Durodoye, 2013; Tinto, 2003).

However, core science courses have been difficult to incorporate into LCs. Core science courses have a very specific and fixed content, especially those that are traditionally lecture based and those that are part of a sequential series of courses (material from one course is necessary for subsequent courses). When science courses are incorporated into LCs, they tend to be only those courses intended for students who are not pursuing a major in the sciences. These non-major science courses often have more flexibility to adjust the course to fit within an LC structure.

If we are committed to the success of students studying the core sciences, then we should explore ways to incorporate core science classes into LCs that employ the high impact practices described in the LEAP report. This commitment seems additionally urgent given the recent U.S. Department of Education report highlighting concerns about the attrition of students out of STEM majors (Chen, 2013). In this article we describe how the first-year LC structure at Wagner College allows core science courses (in fact any course appropriate for entering first-year students) to be incorporated in an LC.

Wagner Plan

Since 1998, Wagner College, a four-year liberal arts college serving approximately 1,850 undergraduate students and 425 graduate students, has developed and implemented a curriculum—*The Wagner Plan for Practical Liberal Arts*—that unites deep learning in and practical application of civic engagement and leadership. Wagner College's civic leadership ranges from local community partnerships (including the Port Richmond Partnership that collaborates with local community organizations and the College's Center for Civic Leadership, supporting community initiatives in response to Superstorm

Sandy) to participation in the national conversation on civic learning (National Task Force on Civic Learning and Democratic Engagement, 2012).

The Wagner Plan integrates learning by linking courses, connecting curricular and co-curricular learning, and applying classroom content to community-focused challenges with deliberate methods of experiential learning and reflective practices. Wagner College students are challenged to apply active learning to real world problems.

The Wagner Plan curriculum consists of three LCs that all undergraduate students complete: the first-year LC, intermediate LC, and senior LC. The first-year LCs and Senior LCs both include an experiential learning component and a reflective tutorial (RFT). The senior LC is contained within each major; as such, each major is able to craft an LC that works best within the discipline.

In contrast, each first-year LC is an interdisciplinary set of three courses connected by a common theme and taught by two full-time faculty members from different disciplines. A cohort of approximately 25 students enrolls in two content classes, each taught by one of the two faculty members. All students take the RFT, which is collaboratively taught by the two faculty members. The goal of the first-year LC is to begin the processes of liberal learning: critical analysis; improvement of reading, observational, and writing skills; and participation in experiences beyond the Wagner College campus.

A faculty member with expertise in teaching writing serves as the Director of Writing and works with all new LC faculty members to determine how to apply informal writing (based on experiences, for the purpose of self instruction) and formal writing (incorporating revision, focusing on intended audience, and developing critical and analytical sophistication).

The faculty members in each first-year LC serve as the academic advisors for the students in the LC until each declares his or her major. The faculty members across LCs comprise the first-year program committee, which has monthly meetings and an annual two-day retreat, led by an elected faculty coordinator. The faculty has ownership of the program and sets the academic standards.

Reflective Tutorial

The RFT is key to each first-year LC. This course replaces the traditional first-year writing course while maintaining learning outcomes focused on critical reading and expository and reflective writing. The RFT emphasizes additional high impact practices, including experiential learning, civic engagement, writing across the curriculum, and readings that explore the theme of the LC and bridge the disciplines in the two other LC courses.

The two faculty members who teach the discipline-specific courses that form the LC determine the content of the RFT, with guidance from a documented set of standards created, adopted, and routinely updated by the faculty committee of the first-year program (see Appendix). These standards include goals for experiential learning and guidelines for types of formal writing to be produced by each student.

The RFT is an ideal vehicle for allowing core science courses to become part of a LC. Core science courses appropriate for first-semester students are often offered through multiple sections that also serve as prerequisites for second-semester courses. Thus. students who take General Chemistry I can—and often do—choose to take General Chemistry II. Because core science courses are usually packed with content that cannot be removed, many two-course models for learning communities would require dramatic adjustment of courses that might reduce the core science content within the LC. However, the three-course Wagner Plan first-year LC model allows core science courses to remain fully intact. The RFT provides the space for bridging the courses within the LC and for offering reflection on high-impact practices. With the three-course model, no disparity occurs across sections of core science courses, whether they are taught within or outside of an LC. Students have sufficient opportunity to study the core science material in order to move on to the next course in the sequence.

At Wagner College we typically offer four sections of General Chemistry I in the fall semester, two of them within a first-year LC. All four sections have identical time to explore the content of the course and all use the same textbook and share the same content goals. Empirical analysis demonstrates that students who complete General Chemistry I in an LC perform at least as strongly in General Chemistry II as do students who completed General Chemistry I in a stand-alone course (see Table 1).

Table 1
Means and Standard Deviations for Performance on Exams in General Chemistry II as a Function of General Chemistry I in an LC or Stand-Alone Course

	In LC (n = 13)	Stand Alone (n = 15 or 14)	Comparison
Exam 1	66.39 (16.34)	67.60 (13.44)	$t(26) = -0.22$, $p = .831$
Exam 2	79.08 (14.38)	66.93 (13.45)	$t(26) = 2.31$, $p = .029$
Exam 3	81.15 (12.83)	80.21 (10.83)	$t(25) = 0.21$, $p = .838$
Final Exam	79.00 (13.24)	72.96 (9.00)	$t(25) = 1.39$, $p = .176$

Core Science Learning Communities

Several previous first-year LCs with Chemistry I and an RFT include *Emerging Global Health Concerns* (combined with Health & Society, a rigorous social science course examining health care systems); *I: Robot: Minds, Machines, and Human Beings* (with a philosophy course, Medical Ethics); and *Clarify Claims: Science, Nature, and Society* (with Microeconomics). Other LCs have contained core science courses from physics, biology, microbiology, mathematics, and computer science. Because the high-impact practices that make the LCs successful are contained within the RFT and the core science course does not need to be modified for the LC, any course open to first-year students can be placed within an LC.

In the RFT for *Emerging Global Health Concerns*, all the students in the LC are exposed to the role of chemistry in issues that affect the health status of individuals and groups throughout the world. The RFT has a series of formal, polished writing assignments (including analysis of challenging reading assignments and a research paper) and informal reflective writing assignments based upon experiential learning activities that include working with local organizations that address community health concerns and carefully constructed field trips.

In *I: Robot: Minds, Machines, and Human Beings,* students examine nanotechnology in terms of links between chemistry and ethics. In the RFT, the students discuss, read, and write about applications of nanotechnology to chemistry and medicine, as well as the risks and benefits that are associated with new technologies. The students' experiential learning activities challenge them to introduce nanotechnology to a variety of audiences, including residents of nursing homes, K-12 educators, and politicians.

Clarify Claims: Science, Nature, and Society focuses on the environment, with an emphasis on the economic factors that lead to environmental sustainability. Formal writing assignments examine issues such as fresh water sources, waste management, and deep ecology. The experiential learning activities include field trips to waste management facilities, community clean up projects, and the creation of publications about local recycling and community gardens.

Outcomes

Beginning with the first cohort of students in the Wagner Plan in 1998, students have been asked to complete an evaluation of every LC, in terms of reflection on learning outcomes and evaluation of the experiential component. This is one of several assessment tools, including typical course evaluations, which provide feedback to faculty members on success and areas for improvement in the LCs. Assessments have been refined over the years to evaluate learning outcome goals related to formal writing, critical reading, and informational literacy. Students provide evaluation of the success of experiential learning and their connection to civic engagement as well as awareness of complex aspects of diversity.

Senior-level students completing a major in chemistry are asked at the end of each your about factors that contributed to their choice of major. Seventy-eight percent (seven of nine students) who took General Chemistry I in a first-semester LC identified the LC experience as a factor contributing to their decision. When given an opportunity to comment on the influence of the first-year LC in the choice of the chemistry major, one student noted, "Absolutely. More than anything else." Another focused on the importance of the connection between faculty and students that occurs in an LC. A third commented that the LC "set the groundwork for the next four years." When asked for additional factors that contributed to choosing the major in chemistry, several students continued to emphasize the importance of the LC. One stated that "my LC" was a deciding factor, another noted "my freshman year RFT" as important. A third commented, "I knew I wanted science, but freshman year made my decision."

While the LC allows faculty members to fully focus on content in General Chemistry I, the RFT provides an ideal place to explore opportunities in research, graduate school, and careers. Topics covered in the RFT were influential in seniors' choices; students noted "future career," "career choices," and "graduate school opportunities" as influencing their decision to complete a major in chemistry. Given that pairing the RFT with General Chemistry I increases the contact hours between faculty and students, it is notable that a student emphasized the importance of connections with faculty, commenting, "My professors made class understandable."

In addition, faculty members have found the experiences gained through teaching the RFT transform their teaching across courses. For example, one faculty member in chemistry has enjoyed opportunities to explore multiple pairings with other disciplines. A partnership with a literature expert yielded an RFT focused on science fiction. Later she was able to explore her academic interest in the environment, first with an economist and later with a biologist. Faculty members regularly express enthusiasm regarding the intellectual inspiration of working with colleagues across disciplines. As one observed, "Similar to the effects of gaining perspective on one's own culture when traveling to a place with different customs and assumptions, the partnership with a colleague from a distinctly different discipline increases my awareness of how chemistry approaches problems and how my discipline can be applied."

The collaboration with a colleague from a different discipline to create the LC and to team teach the RFT provides intellectual challenges and rewards. A dean who oversees LCs at all three levels and the faculty member elected to coordinate the first-year LCs help interested faculty members to explore possible pairings. Chemistry faculty members will always offer General Chemistry I as the content course in chemistry, but they are encouraged to explore creative links with other disciplines. Once a pairing has been identified, the chemistry faculty member works closely with the new teaching partner, who might be from any discipline across the college. The teaching partner identifies an appropriate course in his or her area of expertise for the second content course. The two faculty members coordinate with each other and with the Director of Writing to design an RFT that meet all of the standards for first-year LCs (see Appendix) in a way that makes rich connections between the two disciplines.

Although creating a new LC and developing and coordinating the RFT requires extensive work on the part of both faculty members, the rewards for the effort are clear. Through planning meetings with their teaching partner, faculty members explore ways to discuss how chemistry relates to real-world applications. The RFT itself creates an opportunity for in-depth exploration of engaging content that bridges the two disciplines in the LC. It provides a shared experience for the General Chemistry I instructor and the students. This allows

the faculty member to draw on concrete examples from topics discussed in the RFT and to make connections to practical issues addressed in the RFT.

Finally, through the focus on writing across the curriculum with the support of the Director of Writing, faculty members across disciplines who teach first-year LCs become better teachers of writing. This transforms teaching across a faculty member's courses.

In addition to careful internal assessment of what we achieve by our endeavors, Wagner College's first-year program LCs have been nationally recognized for their excellence (2005 TIAA-CREF Theodore M. Hesburgh Award; *U.S. News & World Report*'s "Programs To Look For" in 2014 and multiple previous years). The success of having at least two of the four General Chemistry I classes contained within first-year LCs has been published previously (deProphetis, Driscoll, Gelabert & Richardson, 2010). In summary, a statistically significant increase occurred in the overall number of students majoring and graduating in chemistry after the adoption of the Wagner Plan, with a statistically significant growth in the number of women selecting to major in chemistry and succeeding through graduation when compared to similar institutions.

Conclusion

As we have shown, Wagner College first-year LCs make possible the incorporation of core science classes into LCs by housing reflection and high-impact practices in the RFT. We encourage faculty and administrators of other institutions to explore creative models for inclusion of content-rich courses (such as introductory science courses) into LCs. Content need not be removed from one course if another course is able to provide a bridge with the content-laden course. Institutions could also explore a model that pairs a composition course with a course from another discipline. This could be successful if the composition course provides the flexibility to make the connections with the other course. This two-course model may be transformative for the composition instructor and students, but might not provide the rich opportunities for concrete connections in the other course.

For those institutions that wish to develop a similar model, there are certain barriers that need to be considered before such a task is undertaken. This model requires full-time faculty members to teach in the RFT, essentially a course outside the discipline, which can strain a department's resources in terms of being able to offer required courses. This strain can be offset by deployment of resources previously invested in the first-year writing course across the curriculum to the many departments providing first-year LCs.

A second issue is the expectation that science faculty will teach writing and lead other high impact practices, tasks that might be beyond their comfort zone.

For the RFT to be successful, we have found that offering professional development opportunities is extremely important. In addition, ensuring sufficient flexibility in RFT design allows faculty members to structure the LC according to their strengths and to develop specific learning goals relevant to desired learning outcomes.

Ultimately, the three-course model with the RFT is a solution that addresses the need for innovative approaches to STEM courses. The model is transformative for both faculty members and the students. The RFT replaces the traditional first-year writing course with a course team taught by two faculty members from any two distinct disciplines as part of a LC. It allows the other courses within the LC to retain the content that would be covered even if not part of the LC. And finally, it creates an opportunity to explore links between the two disciplines and real-world applications of these disciplines.

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Appendix
Wagner College Standards for First-Year LCs

Experiential learning can include any combination of the following types of work in the community:

- service learning with a local community organization,
- field trips to content-relevant locations,
- participatory learning with direct observation of course concepts,
- community research collaborating with a community partner, under the supervision of LC faculty, to gather data on an applied research question.

LCs are expected to offer a total of approximately 30 hours of experiential learning. Informal writing assignments and course discussions prompt students to reflect on connections between experiential learning and course content.

At least three formal, graded writing assignments are required in every RFT. Each student must submit a minimum of 15-20 pages of graded, formal writing. At least one research paper will include work with library staff to enhance skills in information literacy. At least one analytical paper will require students to take a position on a question that is open to interpretation. At least one of these papers must involve explicit work on drafting and revision. The specifics of these assignments vary from one RFT to another, based on the goals of the faculty members and the advice of the Director of Writing.

All RFT sections seek to help students become proficient in these writing skills: composing a thesis statement and developing it through detailed examples, organizing ideas, use of transitions an variety of sentence structures, appropriate integration of quotations, and use of a documentation style.

Reading assignments should explore increasingly complex ideas as the semester progresses. At the end of the LC, students should be able to read for content, structure, and academic significance.