Nontraditional Learning Environments: Do They Prepare Our Students for Life-Long Learning?

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Abstract
Recent research indicates that traditional academic structures may not promote learning consistent with self-directed learning.[1,2] This work investigated whether Worcester Polytechnic Institute's (WPI) nontraditional interdisciplinary projects program increased readiness for life-long learning (LLL) and self-directed learning (SDL) using three methods: a calibrated, validated instrument called the Self-Directed Learning Readiness Scale (SDLRS); a nationally normed and calibrated course evaluation system called the IDEA system; and an internally designed student project quality assessment protocol.

The SDLRS showed a small positive, but not statistically significant, increase in SDL readiness amongst a study abroad cohort. The IDEA system, however, showed study abroad students reporting significantly greater progress in LLL-related skills than did national and local comparison groups. The internal project evaluation found study abroad students consistently outscored on-campus project students on another LLL measure. These mixed results indicate interesting differences and yet unresolved issues in testing preparation for LLL.

Background
Most engineering schools, including WPI, have academic goals that include preparation for life-long learning. Nontraditional academic experiences claim to support preparation for LLL. However, evidence is largely anecdotal or superficial.

LLL "suddenly" became part of engineering education when ABET included it as one of the desired learning outcomes. Most schools have had trouble defining it, and nearly all have trouble measuring it. Many have resorted to outcomes descriptors that relate to information finding abilities, elective course decisions, and participation in professional societies. Despite these outcomes being desirable they are somewhat superficial, low-level abilities. Other methods to probe LLL involve using post-graduation paths and career choice data that are obtained by alumni surveys with low response rates. A rigorous approach says that LLL can't be measured until someone has actually had a life. At present, the best we can do in undergraduate education is to place students in learning environments conducive to developing LLL-related skills, while investigating alternative methods for assessing whether in fact these measures are effective.

The literature clearly indicates that preparation for LLL really includes some complex, deep learning issues. Its definition is much broader than simple information gathering traits. Very often the term "self-directed learning" is used. Oliver suggests LLL is self-actualized learning demonstrated through continuous personal development.[3] Brockett and Hiemstra suggest that

Proceedings of the 2005 American Society for Engineering Education Annual Conference & Exposition Copyright 2005, American Society for Engineering Education.

SDL "is the ability and/or willingness of individuals to take control of their own learning that determines their potential for self-direction."[4] In general, the ability to engage in LLL begins with a student-demonstrated *readiness for SDL*.

One investigation of effective self-directed learning defines it as: "openness to learning opportunities, self-concept as an effective learner, initiative and independence in learning, informed acceptance of responsibility for one's own learning, a love to learn, creativity, future orientation, and the ability to use basic study skills and problem-solving skills." SDL is exemplified by attitudes like "curious/motivated, methodical/disciplined, logical/analytical, reflective/self-aware, flexible, interdependent/interpersonally competent, persistent/responsible, venturesome/creative, confident, independent/self-sufficient"; and skills like "highly developed information seeking and retrieval skills, have knowledge about and skill at the learning process, develop and use criteria for evaluating (critical thinking)."[5]

Besterfield-Sacre and colleagues[6] nicely explicated the ABET ability (recognition of the need for, and an ability to engage in life-long learning) within a framework of Bloom's taxonomy. The outcome elements include a range of abilities such as: basic communication skills, developing learning plans, dealing with information including evaluating integrated information, critical thinking, and analysis of one's ability to reflect on their own understanding and thinking.

As educators our interests involve what we do with our students for four years and how that prepares them professionally, intellectually and emotionally for post-graduation life. Because of its many dimensions it is important to understand LLL, or students' preparedness for LLL, and its connection to the curriculum. Few studies have really probed this connection. Alverno College pioneered work in this area related to liberal arts education. However, their methodologies (longitudinal "perspective" and "behavioral event" interviews) are beyond the scope of this work. Alverno results clearly indicate that experiential learning is persistent.[7] Other appropriate methodologies like alumni surveys are plagued by poor response rates and lack of control for confounding variables that effect post-graduation learning. An evaluation that measures student preparedness for LLL while in college could be used to better connect academic structures and student development in the dimensions described above.

Several engineering schools have implemented nontraditional curricula on a broad scale (WPI, Rose-Hulman, Harvey Mudd, Olin College). Other universities have incorporated new academic structures such as project-based courses, service learning, off-campus internships, international programs, and co-ops. These programs' goals include improved student learning, particularly in dimensions related to LLL. Engineering educators could benefit from knowing the answer to a relatively simple question: *Do nontraditional academic structures result in increased readiness for self-directed learning?* This work sought to answer that question for one type of structure, using a primary and two secondary methodologies. The results would augment and complement those of Litzinger[1,2] and would inform curriculum development in the engineering community.

Thirty years ago WPI implemented nontraditional instructional design, emphasizing project-based education to, amongst other things, better prepare students for lifelong learning. Currently large numbers of students, 350 per year, travel internationally to complete projects that link technology and society. The off-campus portion of this activity is the equivalent of 3 course

equivalents worth of work. Prior to sojourn, all students must complete 1 ½ courses worth of site and project-specific preparation work (4.5 credit hours). The preparation phase is two months on-campus and the project phase is two months off-campus (total time is one semester). During the first two months students have other courses and activities, but once they leave WPI (the second two months) they work full-time on their project. The total preparation and study abroad experience is thus equivalent to 4.5 courses (13.5 credit hours). Students travel in groups of 24 with 1-2 faculty advisors to the international site. On-site work involves teams of 3-4 students working fulltime for local agencies. Sponsors provide the topic, but student teams develop objectives, conduct a literature review, identify appropriate methods, conduct the research, and analyze/interpret the results. All teams produce a final report that is graded for academic credit and teams deliver a formal final presentation to their agency. A typical project could have a CS major, an ME major, and a Chemistry major work on low-cost sustainable housing improvements for shack dwellers in Namibia; advised by a Management faculty member and sponsored by the Namibian Renewable Energy Bureau.

Although space prevents a review of the literature on international programs and student learning, most educators assume that off-campus sojourns have positive effects on student learning, particularly dimensions such as those involved in LLL. Because WPI aims to prepare students for LLL, and it sends so many students off-campus to do significant amounts of nontraditional, non-classroom based work, an opportunity existed to measure growth in SDL readiness in a large sample.

Assessment Options

Self-Directed Learning Readiness

There are two major instruments for assessing students' preparation to engage in LLL and their willingness to do so. They are the Self-directed Learning Readiness Scale (SDLRS), and the Continuing Learning Inventory (CLI). We chose the SDLRS because the literature indicates it is the most studied and used. The SDLRS is a 58 item, Likert-scaled questionnaire available from Guglielmino and Associates.[8] The prompts probe student attitudes toward learning. Included are items such as self-generation of knowledge, responsibility for learning, individual vs. group learning, curiosity about learning, learning environment preferences, study skills, and the importance of continual learning. SDLRS validity has been demonstrated in scores of studies and contexts, particularly with studies correlating SDLRS score and observable student self-directed learning behaviors.[1]

At two recent ASEE meetings Litzinger[1,2] presented studies of engineering students' readiness for SDL. This work showed that traditional engineering education (over 4 years) including capstone design courses had little positive effect on SDLRS. His conclusions were that "…most courses that students take in the undergraduate engineering programs do not ask them to undertake tasks that increase their readiness for self-directed learning."

Student Perceptions of Gains in LLL Dimensions

To supplement the SDLRS analysis, we used secondary data obtained through the IDEA System (the Individual Development & Educational Assessment Student Ratings of Instruction System), a course evaluation product of the IDEA Center at Kansas State University designed to focus on

student learning, "[r]ather than emphasizing the instructor's teaching techniques or personality" (IDEA Center website: http://www.idea.ksu.edu/). Key learning metrics include student progress on learning objectives determined by the instructor to be "essential" or "important" to each particular course, as assessed through the familiar end-of-course, anonymous student course evaluation and self-assessment of progress. The IDEA System is widely used. For example, between August 1998 and August 2001, the IDEA System was used to assess student learning in more than 70,000 classes at 122 institutions varying widely with respect to size, location, degrees granted, public\private, etc.[9]

Instructors are advised to select 3 to 5 objectives from the IDEA System's list of 12 possible learning objectives. We identified 4 learning objectives that are *important* or *essential* outcomes of the study abroad experience, beginning with the on-campus preparation course. These objectives are: *Team work* ("Acquiring skills in working with others as a member of a team"*); E*xpression ("Developing skill in expressing oneself orally or in writing")*; Critical thinking* ("Learning to analyze and critically evaluate ideas, arguments, and points of view"); *Research skills* ("Learning how to find and use resources for answering questions and solving problems").

Changes in a student's capacity for teamwork, expression, research and critical thinking are valid measures of one's readiness for, if not inclination to pursue, LLL and SDL. Nationally, one-third to one-half of all classes in the IDEA System stressed these four objectives (*teamwork* 32%, *research skills* 41%, *oral and written expression* 46%, and *critical thinking* 49%) and another objective logically related to LLL and SDL (*acquiring an interest in learning more by asking my own questions and seeking answers* 41%).[9]

Evidence for LLL in Student Final Reports

In any assessment analysis it is important to collect data that represent actual student outcomes in addition to student perceptions or other indirect measures. In our educational process there are two major outcomes: the project team's final presentation and final written report. Analysis of presentations at sites all over the globe was not feasible but analysis of final reports is possible.

Periodically, WPI evaluates all reports produced by student teams completing the technology-society project. This is about 200 reports done each year, both on and off-campus. The evaluation uses an internally developed instrument with trained and calibrated reviewers.[10] Currently we have only one question on the 35-question evaluation form that relates to LLL assessment. The question probes "the extent to which the students acquired and applied knowledge not obtained from prior course work." The rubrics for this prompt are: *excellent*--the project contains an extensive, critical literature review on a topic and makes extensive and effective use of recognized, respected, and appropriate methodologies not likely to have been covered in the students' coursework; *acceptable*--the project contains an acceptable literature review on a topic and makes significant use of appropriate methodologies not likely to have been covered in the students' coursework; and *poor*--the project makes only very limited use of background knowledge or methodologies not likely to have been covered in the students' coursework.

The question may be flawed in that it presumes the reader knows all the students' previous work and can identify by reading the report what knowledge each student created. In practice, application reduces to rating the quality of the literature review. Because the projects are multidisciplinary and do not depend upon discipline-specific knowledge, application of the rubric can provide evidence regarding one dimension of LLL.

Methodology

Self Directed Learning Readiness

We implemented the SDLRS tool over the entire student cohort that went off-campus during the 2003-4 academic year. We have four preparation-sojourn cycles during the academic year and one during the summer. The pre-test was conducted at the first meeting of the preparation period. There were twelve separate preparation applications. Since the preparation experience is primarily a traditional classroom structure we had a captive audience for the pre-test, hence we had a high completion rate for pre-tests. The post-test was conducted as each student team completed their project. There were twelve different off-campus locations throughout the world. On-site project advisors supervised SDLRS application and data collection. Obtaining high completion rates for the post-test was problematic since student teams are in the field during their sojourn and are extremely busy during the end of the project, completing final reports and giving final presentations to their sponsors. Despite these issues we obtained acceptable overall response rates. Students completed the form anonymously but we coded for gender, age, and project site. Following completion of all post-tests, the results were sent to Guglielmino & Associates for analysis.

IDEA System Course Evaluations

We implemented the IDEA course evaluation form at the end of some of the pre-sojourn preparation classes. This meant students had completed writing a project proposal, have had some site-specific cultural training and have completed the preparation course, but have not yet left campus for their actual project work.

We compared data from IDEA System Group Summary Reports amongst three groups: The IDEA System nationally, WPI institutionally, and this study abroad preparation course taught at WPI. We assessed the effectiveness of the project preparation phase in meeting the 4 SDL and LLL related learning objectives detailed above, and compared these results on each objective with other courses in the IDEA System nationally and at WPI that also designated the objective as important or essential. WPI at the time of this writing was only in the second year of a two year trial to explore adopting the IDEA System permanently thus, as of January 2005, data were available for only 9 preparation classes, versus (for each objective) over 200 WPI classes and over 12,000 IDEA System classes. The total number of student respondents from the preparation classes, however, was 184, a reasonable basis for early analysis.

Evidence for LLL in Student Final Reports

The methodological details of our internal review of all reports completed during a calendar year are described elsewhere.[10] We extracted the data specifically related to LLL from reviews completed during the summers of 2002 and 2004. The off-campus cohorts were compared to the on-campus cohorts.

Results

SDLRS Results

The results of the pre-post test analysis for the entire off-campus cohort returning valid questionnaires are shown in Table 1. Improperly coded response sheets or sheets with more than four missing responses were rejected. An independent samples t-test was applied. The final response rate of 75% was acceptable.

Despite the positive increase in the mean SDLRS scores for the post-test mean compared to the pre-test mean, the results were not statistically significant (t=-0.931 and p=0.352).

Table 1: SDLRS Results for Study Abroad Cohort

	N	Mean	Std. Deviation	Std. Error Mean
Pre-test	210	217.3	23.65	1.63
Post-test	158	219.7	24.97	1.99

These results are similar to those obtained by Litzinger and colleagues.[1,2] The means shown here are somewhat lower than those reported by Penn State seniors in capstone design but are comparable to juniors at Penn State.[1] All the students in the WPI cohort were 5th or 6th semester juniors. Our results indicate that on average, students who completed a significant multidisciplinary project requirement at an off-campus location do not exhibit significant gains in SDLRS scores. As of the writing of this manuscript, analyses from the on-campus cohort and gender and project location comparisons are in-progress, as are results from two summer off-campus programs.

IDEA System Course Evaluations

The data used to assess the effectiveness of the study abroad preparation in meeting the SDL and LLL related learning objectives against other courses nationally and at WPI was from self-reported student assessments of development on a 5-point scale ("My progress on this objective was" 1 = Low, 5 = High). In interpreting results, it is important to note that, on average, students report making significant progress on all learning objectives deemed critical or essential in a particular course (i.e., college classes are generally producing desired results). For all 4 objectives analyzed here, the average student responses were: IDEA system 3.8 (+\- 0.1), WPI 3.6, and the study abroad preparation 4.3 as shown in Table 2. In all cases, average ratings were substantially higher for the preparation course than for the IDEA System and WPI as a whole, with students particularly reporting improved teamwork skills.

Table 2. Comparison of Average Student Responses from IDEA Course Evaluations

Objective	IDEA	WPI	Study Abroad Prep Course
Teamwork	3.9	3.8	4.6
Expression	3.8	3.5	4.3
Critical Thinking	3.8	3.5	3.9
Research Skills	3.7	3.5	4.2
Average	3.8	3.6	4.3
# Classes (average)	16,487	230	9

Another way to analyze collective student progress is to consider the frequency with which students report meeting certain thresholds of progress. Figures 1 and 2 below show for each objective and each population the cumulative percentage of classes reaching three average ratings thresholds (3.50, 3.75, and 4.00). Results shown are for two objectives closely related to SDL—critical thinking and research skills. In all cases, ratings were substantially higher for the prep classes than for the IDEA System (by 31% on average) and WPI as a whole (by 39% on average). The most notable difference lies in the low levels of study abroad students reporting little or no progress on the learning objectives, as indicated by all preparation classes achieving an average student response of 3.5 or greater on all four objectives, save for one class on one objective (critical thinking).

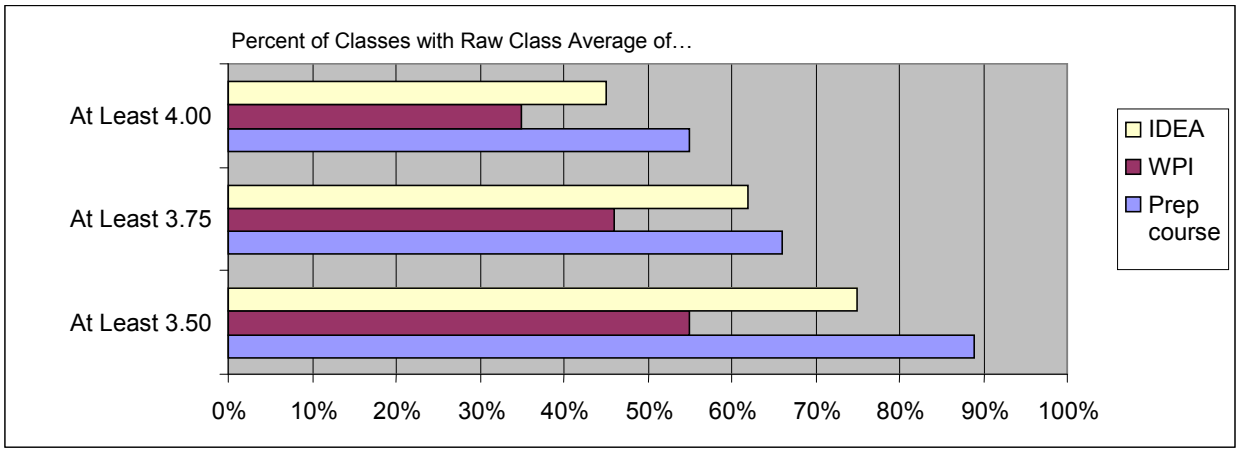

Figure 1: Average Rating Thresholds from IDEA Results for the Critical Thinking Objective

Evidence for LLL in Student Final Reports

Table 3 summarizes the results from the two most recent final report evaluation cycles (2002 and 2004). The sample sizes are lower in 2004 because we only analyzed a random sample of final reports to reduce expenses. Note that there are 3-4 students per team and sample sizes represent numbers of teams. The numerical rating score is 1=poor (or absent), 3=acceptable, and 5=excellent. The 2004 results are from the same off-campus cohort reported above. Although the 2002 results are from a different cohort, they indicate historical consistency. In fact, we have data going back several years that show the same result. That is, that the off-campus project experience provides better evidence of LLL abilities (in the dimension assessed) than the on-campus experience. Off-campus cohort averages are higher than on-campus and there is a striking difference in the percent of reports rated below acceptable.

Also shown in Table 3 are the overall quality ratings. This rating is a summary evaluation of all project aspects: objective definition, literature synthesis, methodologies, data collection, results and analysis, writing and presentation quality, and overall depth. The differences between off and on-campus projects are clear.

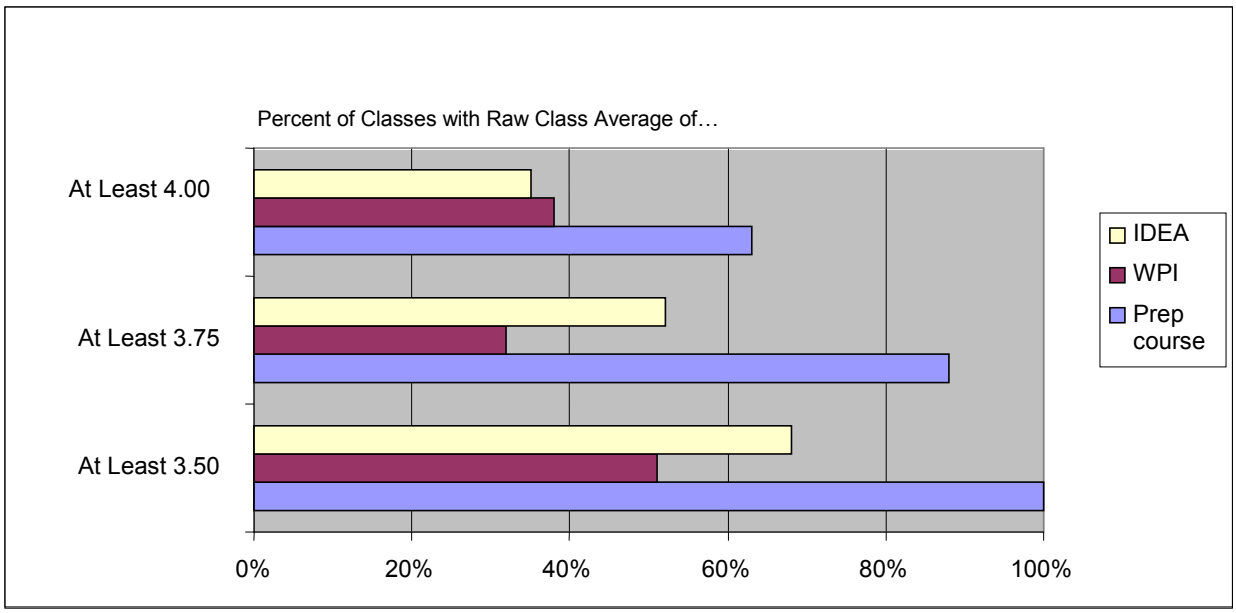

Figure 2. Average Rating Thresholds from IDEA Results for the Research Skills Objective.

Table 3. Results of Final Report Analysis for Two Recent Evaluation Periods

	Off-campus	On-campus
2002 results:		
N	77	119
Ave rating for LLL item	**4.13**	**3.1**
% rated below acceptable	3.8	25.2
Overall Quality Rating	4.20	2.98
2004 results:		
N	35	62
Ave rating for LLL item	**3.91**	**2.73**
% rated below acceptable	3	44
Overall Quality Rating	3.6	2.4

Discussion

We investigated student progress on educational outcomes related to LLL that most colleges agree are essential for their graduates. The success of traditional and nontraditional curricula in delivering these outcomes, however, is only indirectly measurable because they relate fundamentally to future behavior: the life-long and self-directed learning activities of students. Thus, as we noted earlier, research about how to meet and measure these important educational goals remains incomplete, and there continues to be a need for critical testing of both educational approaches and outcomes assessment.

Overall, our results are mixed and somewhat contradictory. Much more than others, students in the preparation phase of the off-campus project experience see themselves having made

significant progress in their writing, critical thinking, research skills, and teamwork abilities. Further, tangible evidence at the end of the project, in the form of final reports assessed independently by faculty teams, shows study-abroad students clearly demonstrating these abilities at higher levels than those who conduct their projects on campus. Nonetheless, although students feel they have grown in important ways closely linked to LLL, and independent faculty see evidence of same, the SDLRS results do not detect any significant improvement in readiness for self-directed learning. How do we interpret these results? First, we reflect on aspects of each measure individually, and then consider possible explanations for differences amongst them.

The SDLRS results suggest WPI's nontraditional, project-based, study abroad experience does not lead to significant improvements in student readiness for self-directed learning. Despite the intense experience, perhaps the time away from campus (2 months) is not sufficient to expect improvements. We know that most students go through personal and professional changes even during 2-month sojourns, yet some study abroad research has shown that students can exhibit negative changes in self-confidence and self-efficacy affecting their world view and resulting in questioning their career path.[11] We have observed this, anecdotally, in some WPI students. How this impacts SDLRS scores and how this might change over time, post sojourn is not known.

The IDEA results show that study abroad students' perception of progress on specified objectives related to LLL is better than that achieved through on-campus projects and traditional coursework. This is after only 1 ½ courses of preparation work, prior to leaving campus. Expectations for writing, presenting, critical thinking, and developing research skills may be greater, on average, in the preparation course than in other courses at WPI that share these objectives. The knowledge that students must meet sponsor expectations, as well as our educational standards, plus the necessity to pass, obligations to teammates and sponsors, the "rite of passage" aspect of the project, all may lead to greater effort by students on the course and its objectives. Students report working much harder during the preparation course, and enjoying it less, than other courses.

The IDEA System is new and not universally popular at WPI. With a fairly steep learning curve, it is possible the WPI data is skewed due to measurement issues related to faculty or students being unfamiliar with the tool. We suspect project preparation instructors are more likely, in general, than other WPI faculty to have embraced the IDEA System and taken advantage of training in its use. However, such issues likely are not pertinent to comparisons with the IDEA System as a whole, where many faculty are long experienced in its use.

Finally, independent faculty assessment of final project reports indicate the study abroad experience exceeds the on-campus experience in student capacity for self-directed research, critical analysis and writing. The higher overall performance of study abroad cohorts (only slightly related to GPA—data not shown) indicates that these students can address and solve some fairly complex, open-ended, multidisciplinary problems. These are the kind of problems typical of post-graduate professional life when SDL might be more clearly manifested.

Differences observed through these alternative assessment tools likely relate both to the complexity of the experience studied and to differences amongst the "time sensitivity" of the different measures. The faculty observations and IDEA System reports of students focus on near-

term phenomena: are study abroad final reports summarizing the project experience demonstrably better than those written for projects done on campus? Do students, prompted to look back over two months of project preparation, report feeling greater improvement in their abilities in key LLL\SDL dimensions than do other students? That the answer to these questions is "yes," whereas the answer to SDLRS test measuring the more amorphous incorporation of independent learning qualities into a student's self-identity, tastes, and anticipated behaviors seems to be "no," may reflect a failure of this nontraditional educational model to stimulate the incorporation of the intensive project experience into personal SDL development. Alternatively, it may reflect a more tectonic pace of true and lasting personal growth and development, and\or the need for students to apply the lessons learned in later analogous situations for them to perceive such development. Likely, it is both: some students benefit little from the experience in terms of SDL, while others, as many tell us anecdotally, look back on the experience as one of the first in a series of open-ended learning challenges encountered throughout their later careers.

Finally, we believe the results also point to the need for more direct measures that do not rely upon student self-perceptions and attitudes. Qualitative methodologies such as interviews, observation, or ethnography would be particularly useful. They allow for a deeper and more detailed understanding of student learning (and preparation for self learning) that is constructed by interpreting observed behaviors and responses rather than relying on self-reports. Although such work was beyond the scope of the current study, our results do help provide a base for future research design. We hesitate to recommend curriculum changes without such additional research.

Acknowledgement: *A portion of this work (SDLRS part) was funded by an ERM Division mini-grant for which the authors are grateful.*

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